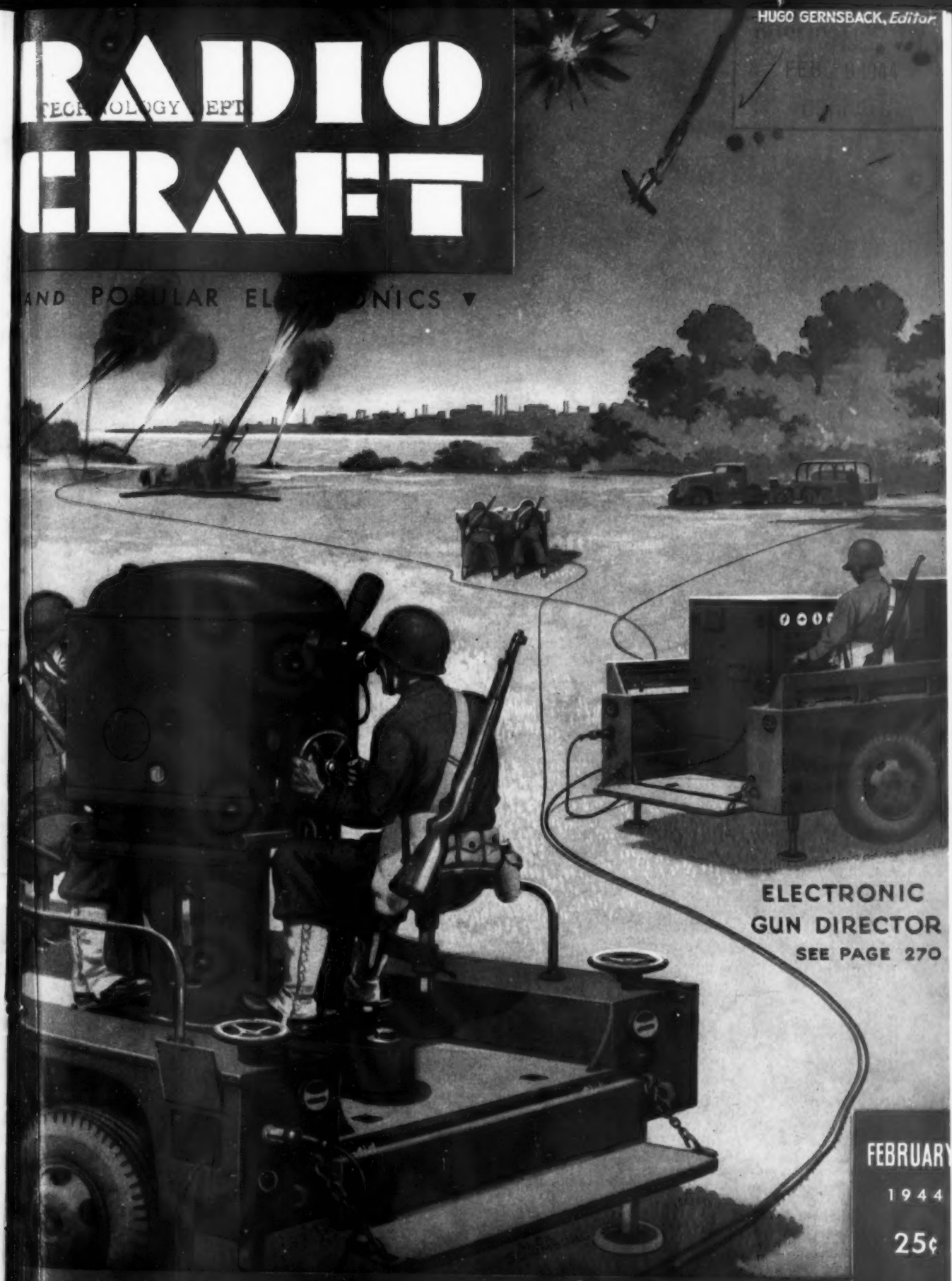
TECHNOLOGY DEPT

RADIO CRAFT

AND POPULAR ELECTRONICS ▼

HUGO GERNSBACK, *Editor*



ELECTRONIC GUN DIRECTOR

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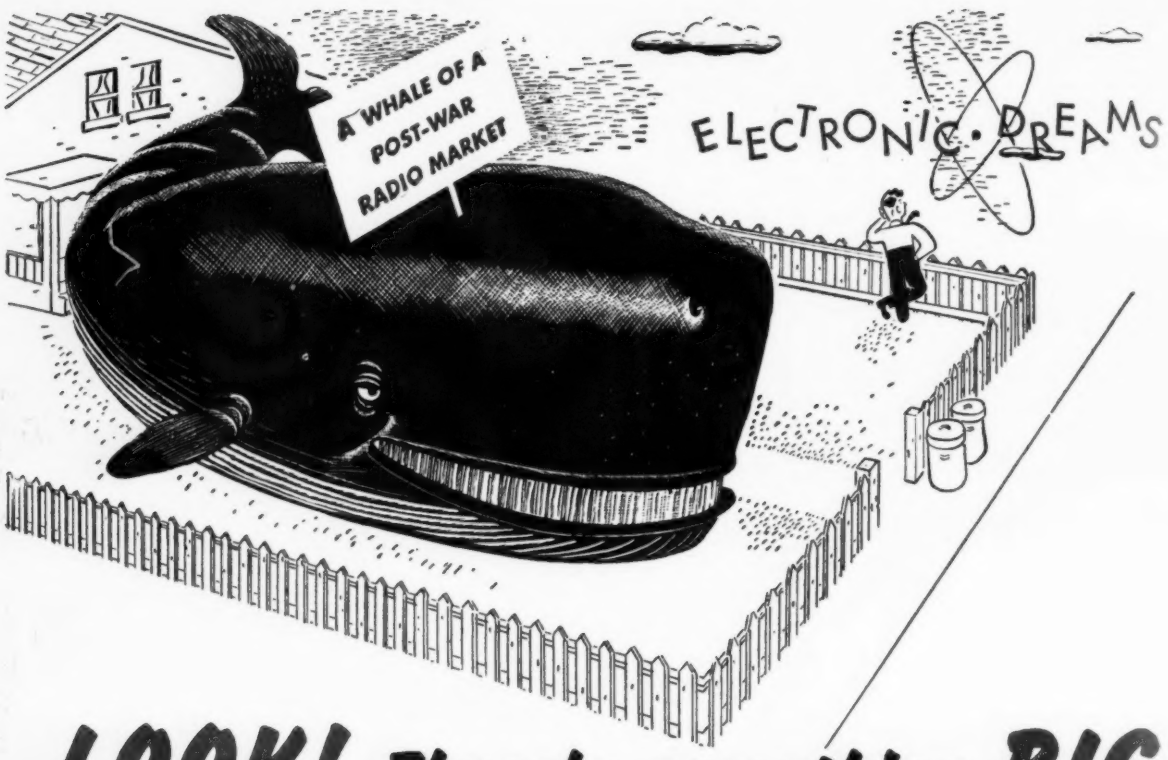
FEBRUARY
1944
25¢
CANADA 30¢

RADIO-ELECTRONICS IN ALL ITS PHASES



LOOK! There's something BIG right in your own back yard!

Yes sir! There's going to be a "whale of a market" for Radios and Phonographs after the war. Pent-up consumer demand will loose itself on the Radio Dealer with the fury of a Kansas cyclone. Post-War Planning at the famous Motorola Radio factory has kept its engineering and merchandising eyes on this gathering storm and we are confident what America will *need and want* from Radio Dealers is good Radio Receiving Sets and Phonograph Radio Combinations.

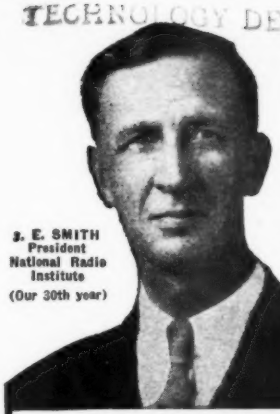
Electronics? Sure! Radio Set production *has been and will continue to be* the number one mass-production item in Electronics. Everything we have learned about Electronics during the war cannot possibly be incorporated into the first Post-War Radio Sets. The future is bright with promise . . . but let's not forget to LOOK . . . at that something Big in our own backyard. There'll be a whale of a Post-War market for Radio and you can bet that Motorola will be ready for it.

Expect Big Things From Motorola — They're in the Making!

For the continued development and production of Radio Communications and other special Electronic equipment for our Armed Forces, the Motorola organization has been awarded two stars for their Army-Navy "E" Flag. Motorola is proud of the part it has been privileged to play in the speeding of Victory.

Motorola RADIO
FOR HOME & CAR
GALVIN MFG. CORPORATION · CHICAGO, ILLINOIS

TECHNOLOGY DEPT.



J. E. SMITH
President
National Radio
Institute
(Our 30th year)

I WILL TRAIN YOU TO START

A SPARE TIME OR FULL TIME

RADIO SERVICE BUSINESS

WITHOUT CAPITAL

I Trained These Men

These Men Have SPARE TIME BUSINESSES

"I repaired some Radio sets when I was on my tenth lesson. I really don't see how you can give so much for such a small amount of money. I made $600 in a year and a half, and I have made an average of $10 a week—just spare time."—JOHN JERRY, 1337 Klamath St., Denver, Colorado.

"I am engaged in spare time Radio work. I average from $5 to $10 a week. I often wished that I had enrolled sooner because all this EXTRA money sure does come in handy."—THEODORE K. DuBREE, Horsham, Pa.

"I am doing spare time Radio work, and I am averaging around $500 a year. These extra dollars mean so much—the difference between just barely getting by and living comfortably."—JOHN WASHKO, 97 New Cranberry, Hazleton, Penna.

I Trained These Men

These Men Have FULL TIME BUSINESSES

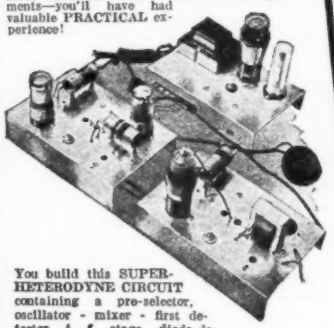
"For several years I have been in business for myself making around $200 a month. Business has steadily increased. I have N.R.I. to thank for my start in this field."—ARLIE J. FROEHNER, 300 W. Texas Ave., Goose Creek, Texas.

"My loudspeaker System pays me about $35 a week besides my Radio work. If it had not been for your Course, I would still be making common wages."—MILTON I. LEIBY, JR., Topton, Pa.

"I started Radio in the Marines in 1917. Later I started studying Radio with N.R.I. I recommend N.R.I. Training to any man no matter how long he has worked in Radio. I now have my own business."—CHARLES F. HELMUTH, 16 Hobart Ave., Absecon, N. J.

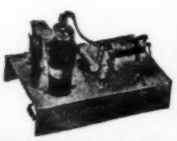
You Build These and Many Other Radio Circuits With Kits I Supply!

By the time you've conducted 60 sets of Experiments with Radio Parts I supply—have made hundreds of measurements and adjustments—you'll have had valuable PRACTICAL experience!



You build this SUPER-HETERODYNE CIRCUIT containing a pre-selector, oscillator - mixer - first detector, i. f. stage, diode-detector-a.v.c. stage and audio stage. It will bring in local and distant stations. Get the thrill of learning at home evenings in spare time while you put the set through fascinating tests!

You build this MEASURING INSTRUMENT yourself early in the Course, useful for practical Radio work on neighborhood Radios to pick up EXTRA spare time money. It is a vacuum tube multimeter, measures A. C., D. C. and R. F. volts, D. C. currents, resistance, receiver output.



Building this A. M. SIGNAL-GENERATOR will give you valuable experience. Provides amplitude-modulated signals for test and experimental purposes.

$600 BEFORE GRADUATING, KITS HELPED

"From your Experimental Kits I learned how electricity worked, how to connect the three stages of a Radio together, also the practical basis for the operation of different parts of a set. I made about $600 or $700 before I graduated."—S. G. PIERSON, Box 71, Dry Creek, W. Va.

FREE TRIAL LESSON

I will send you FREE a Sample Lesson, "Getting Acquainted with Receiver Servicing," to show you how practical it is to train for a good pay Radio job at home in spare time. It's a valuable lesson. Study it—keep it—without any obligation whatsoever. Tells how Superheterodyne Circuits work—why Radio Tubes fail—how to fix Electrodynamic Loudspeakers and Output Transformers—how Gang Tuning Condensers work. Gives hints on I. F. Transformer Repair—how to locate defective soldered joints—Antenna, Oscillator Coil facts—Receiver Servicing Technique—dozens of other hints, facts, explanations. Illustrated with 31 photos, sketches, drawings. Get your copy at once—mail the coupon NOW!

TRAINING MEN FOR VITAL RADIO JOBS

The men above are just a few of many I have trained at home in spare time to be Radio Technicians. Today they are operating their own successful spare time or full time Radio businesses. Hundreds more of my men are holding good jobs in practically every branch of Radio, as Radio Technicians or Operators. Aren't these men PROOF that my "50-50 Method" of training gives you, in your spare time at home, BOTH a thorough knowledge of Radio principles and the PRACTICAL experience you need to help you make more money in the fast-growing Radio industry?

More Radio Technicians Now Make $50 a Week Than Ever Before

There's a big shortage today of capable Radio Technicians and Operators. Fixing Radios pays better now than ever before. With new Radios out of production, fixing old sets, which were formerly traded in, adds greatly to the normal number of servicing jobs. Broadcasting Stations, Aviation and Police Radio, and other Radio branches are scrambling for Operators and Technicians. Radio Manufacturers, now working on Government orders for Radio equipment, employ trained men. The Government, too, needs hundreds of competent civilian and enlisted Radio men and women. You may never see a time again when it will be so easy to get started in this fascinating field.

Be Ready to Cash in on Jobs Coming in Television, Electronics

Think of the NEW jobs that Television, Frequency Modulation, Electronics, and other Radio developments will open after the war! You have a real opportunity. I will train you to be ready to cash in when Victory releases the amazing wartime Radio developments for peacetime uses!

Many Beginners Soon Make $5, $10 a Week EXTRA in Spare Time

Right now, probably in your neighborhood, there's room for more spare and full time Radio Technicians. Many N.R.I. Students make $5, $10 a week EXTRA MONEY fixing Radios in spare time while learning. I send EXTRA MONEY JOB SHEETS that tell how to do it!

My "50-50 Method"—half building and testing real Radio Circuits, half learning from easy-to-grasp, illustrated lessons—is a tested, proven way to learn Radio at home in spare time. Within a few months you can be ready to run your own Spare Time Shop, fix the Radios of your friends and neighbors—get paid while learning!

Extra Pay in Army, Navy, Too

Men likely to go into military service, soldiers, sailors, marines, should mail the coupon now! Learning Radio helps men get extra rank, prestige, more interesting duties, MUCH HIGHER PAY. Also prepares for good Radio jobs after service ends. Over 1,700 service men now enrolled.

Mail Coupon for Sample Lesson and 64-Page Book—Both Free

MAIL THE COUPON. I'll send you a FREE Lesson and my valuable, 64-page, illustrated book. They're packed with facts about Radio. You'll see snapshots and letters from men I trained, so you can know what N.R.I. did for others. You'll read a description of my Course—"50-50 Method"—6 Experimental Kits—EXTRA Money Job Sheets. You'll have my free lesson to keep. And you'll see many fascinating jobs Radio offers and how YOU can train at home. No obligation—no salesman will call. If you want to JUMP YOUR PAY—mail Coupon in an envelope or pasted on penny postcard! J. E. SMITH, President, Dept. 4BX, National Radio Institute, Washington 9, D.C.

GOOD FOR BOTH 64 PAGE BOOK SAMPLE LESSON FREE

J. E. SMITH, President, Dept. 4BX,
National Radio Institute, Washington 9, D. C.

Without obligating me, mail your Sample Lesson and 64-page book, FREE. I am particularly interested in the branch of Radio checked below. (No salesman will call. Write plainly.)

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. . Service Technician for Radio Stores and Factories	. . Operating Broadcasting Stations
. . Spare Time Radio Servicing	. . Army, Navy Radio Jobs
. . Government Civilian Radio	. . Operating Police Radio Stations
	. . Operating Ship and Harbor Radio

(If you have not decided which branch you prefer—mail coupon for facts to help you decide.)

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Address .....

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RADIO CRAFT
▼ AND POPULAR ELECTRONICS ▼

"RADIO'S GREATEST MAGAZINE"

HUGO GERNSBACK, *Editor-in-Chief*
FRED SHUNAMAN, *Associate Editor*
G. ALIQUO, *Circulation Manager*

IN THE NEXT ISSUE

Parachute Radio Raiders
Coming Electronic Wonders
Industrial Electronics
FM Receiver Adjustment
Electronic Life Detector
Stage by Stage Testing

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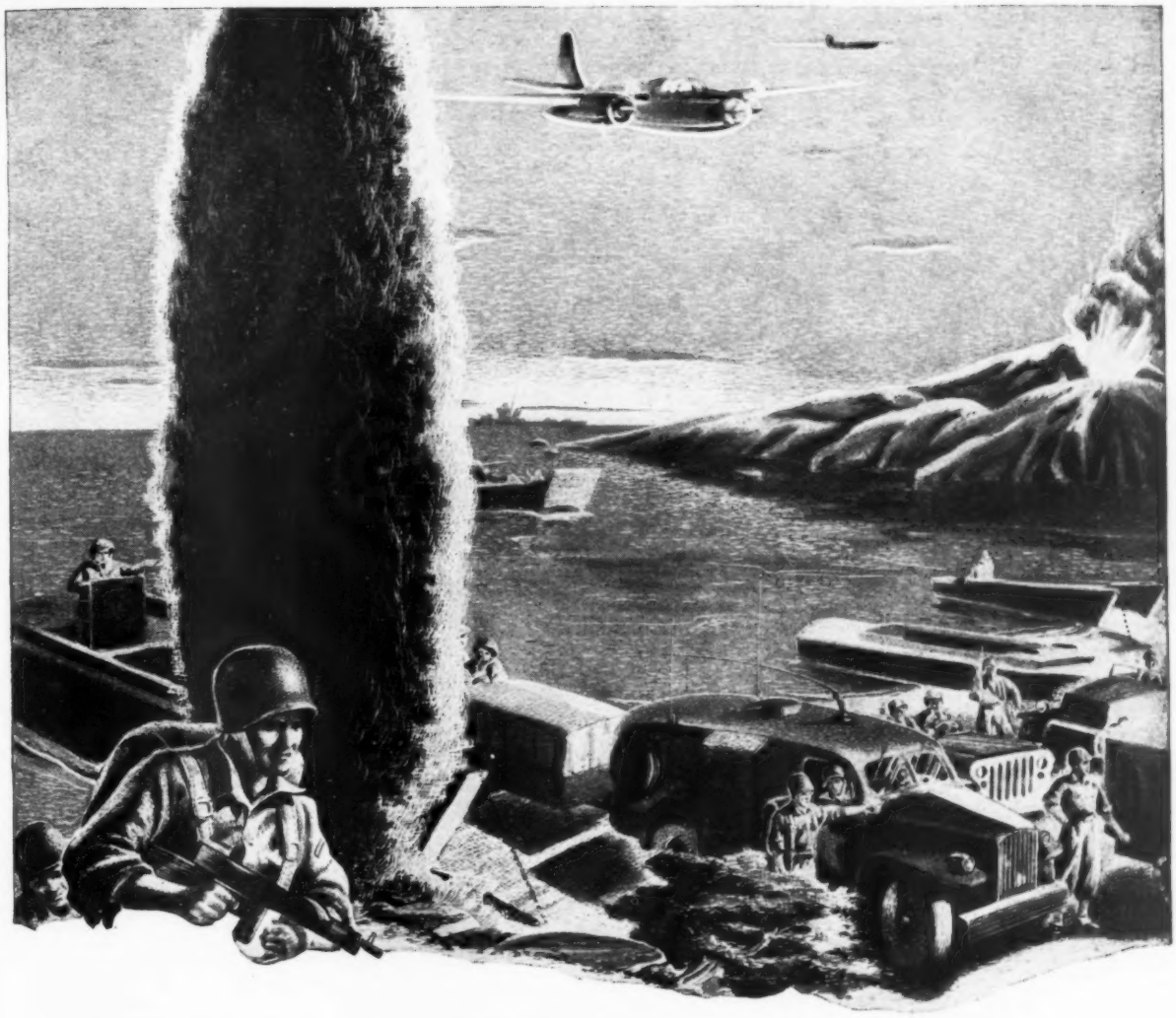
ON THE COVER

Is an illustration of how a surprise air attack might be halted with the help of the Electronic Gun Director. The tracer unit is in the foreground. The computor, which takes data from the tracer and supplies signals which direct the guns, is at the right. The unit at center, with two men bent over it, determines the plane's height.



THE GIANT OF MILITARY RADIO

The Army's SCR-299 Communications Unit!

As beachheads and command posts are established, the SCR-299 built by Hallicrafters speeds ashore and immediately starts operation in voice and code, while stationary or speeding through woods and along rough roads under enemy fire.

Today these Giants of Military Radio are repeating this tough job, with the Allied Nations, on all the battlefronts of the world. Whether directing the fire of battle wagons lying offshore or the concentration of Allied land forces' fire on a strategic hill, the SCR-299 "gets the information through!"

HALLICRAFTERS HAS THE HONOR OF BEING THE 1ST EXCLUSIVE RADIO MANUFACTURER TO RECEIVE THE ARMY-NAVY PRODUCTION AWARD FOR THE 3RD TIME! THE WORLD'S LARGEST EXCLUSIVE MANUFACTURER OF SHORT WAVE RADIO COMMUNICATIONS EQUIPMENT

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BE A

RADIO-ELECTRONIC TECHNICIAN!

SPRAYBERRY TRAINS YOU QUICKLY FOR WAR AND PEACETIME WORK

IF YOU REMAIN A CIVILIAN OR ENTER MILITARY SERVICE . . . Radio Training Will Enhance Your Future!

• READ THESE LETTERS •

One Job Nets About $26.00

"Since last week I fixed 7 radios, all good-paying jobs and right now I am working on an amplifier system. This job alone will net me about $26.00. As long as my work keeps coming in this way, I have only one word to say and that is 'Thanks to my Sprayberry training' and I am not afraid to boast about it."—ADRIEN BENJAMIN, North Grosvenordale, Conn.

Sprayberry Graduate Wins Out in Army Test

"Since I completed your elegant Course in Radio I have been drafted into the Army and put into the Signal Corps. I had to compete to get the job I now hold and as a result of my training with you, I made the best grade and got the job. The point I am driving at is if it hadn't been for your thorough course in Radio I would probably be peeling potatoes now. I recommend your training to all because it is written in language that the average layman can understand."—ABCH PLUMMER, JR., Fort Meade, Md.

Student Makes $15.00 to $20.00 A Week in Spare Time

"After starting your Course I began doing minor radio service jobs and I want to say that I have been flooded with work. So much so that I have had to neglect my lessons. I want to say your training has done a great deal for me. I am making $15.00 to $20.00 a week in spare time. Even so, I'm going to go back to my studies and finish the Course."—SANFORD J. CHICOINE, Whitley, Ontario, Canada.

You Do Practice-Giving Experiments *with Real Equipment*

The offer I make you here is the opportunity of a lifetime. It's your big chance to get ready for a wonderful future in the swiftly expanding field of Radio-Electronics INCLUDING Radio, Television, Frequency Modulation, and Industrial Electronics. Be wise! NOW is the time to start. No previous experience is necessary. The Sprayberry course is short, intensive, and interesting. It starts right at the beginning of Radio. You can't get lost. It gets the various subjects across in such a clear, simple way that you understand and remember.

You Get a Dual-Purpose Radio Set

I supply you with Radio Parts which you use to gain pre-experience in Repair work. These same Parts are used for testing and for Signal Tracing, etc. I make it easy for you to learn Radio Set Repair and Installation Work . . . by practical, proved, time tested methods. I teach you how to install and repair Electronic Equipment. Your success is my full responsibility.

Prepares You for a Business of Your Own . . . or Good Radio Jobs

My training will give you the broad fundamental principles so necessary as a background no matter what branch of Radio you wish to specialize in. Soon you'll be qualified for a good paying job in one of the nation's Radio plants doing war work OR a business of your own. If you enter the Army, Navy, or Marines, my training will help you win higher rating and better pay. Let me prove what Sprayberry training can do for you.

JUST OFF THE PRESS!

"How to Test and Repair Radio Sets Without Meters"

Developed in the Sprayberry laboratory, this instructive volume tells about an amazingly simple, yet efficient method for Radio trouble-shooting and repair without use of regular equipment made scarce due to war. Send for this free book now while the supply lasts and along with it, I will send you another big free book describing my Radio - Electronic training. Mail coupon.

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Please rush my FREE copies of "HOW TO TEST AND REPAIR RADIO SETS WITHOUT METERS" and "HOW TO MAKE MONEY IN RADIO."

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Address .....

City .....State .....

Tear off this coupon, mail in envelope or paste on penny postcard.

NOW! BECOME A MONEY-MAKING RADIO SPECIALIST

SPRAGUE TRADING POST

A FREE Buy-Exchange-Sell Service for Radio Men

SWAP OR SELL—Light meter, several AC & DC meters (used), also large filter chokes. Want sig. generator, tubes, or what have you? Leitch Radio Electric, 34 Park Drive So., West Orange, N. J.

WANTED—Good communications receiver such as R.M.E. #69. New or used, to work on 220-volt line. $50 or $60 cash available. Pfc. Wm. S. Jolley, A.S.N. 39276398, 335th Fi. Sqdn. 4th Fi. Gp., A.P.O. 637, c/o Postmaster, New York, N. Y.

WANTED—Hallicrafters Sky Traveler S-29, or other portable com. receiver. Aviation Cadet J. M. Hoffer, Sqdn. "Y," A.A.F.T.T.C., T.S., Yale University, New Haven, Conn.

FOR SALE—Hickok 510X tube checker and 177X sig. generator; Astatic T3 mike with connector, cable & floor stand; Vibroplex speed key; Weston VU meter type B scale; other misc. meters; Andrea 5" television receiver in cabinet converted for FM (CR tube needs repair); 80-cycle tuning fork (needs new contacts); misc. used tubes—write for list; Weston exposure meter #650. Want late 8mm. camera and projector and good still camera. A. Pane, 1929 E. 18th St., Brooklyn, N. Y.

FOR SALE—Radio & transmitter parts and supplies incl. condensers, dials, coils, meters, tubes, transformers, chokes, etc. Send for list. Leo F. Kersey, White Sulphur Springs, W. Va.

NEEDED BY SOLDIER—One 50L6 and one 32L7 tube to replace those gone dead in personal radio. Who will help out here? Cash. Corp. Nicholas J. Denaro, 331 S/L Bn., A.A.A., Fort Bliss, Texas.

WANTED—Superior set tester No. 1280; signal generator No. 1230; channel analyzer, or other make tube tester, V-O-M, and sig. generator. Donald J. Besson, 1210 Louisa St., New Orleans 17, La.

WANTED—Late model R-F oscillator. Have Hickok tube tester to trade if wanted. Taylor's Radio Shop, Boonville, Ind.

WANTED FOR CASH—Late type tube tester, V-O-M, chanalyst, and Rider's vols. 1, 2, 3, 4, 5, 9, 10, 11, 13. Baldwin Radio Service, 472 East "E" St., Colton, Calif.

FOR SALE—Meissner or G.I. recorder and play back (single record, not automatic) mtd. on metal panel, $30; 5 small crystal speakers (Shure) slightly used, $5 ea. I need 8-9" V-O-M or voltohmyst. Hickok Jumbo #133 or 210S; also Hickok sig. generator. University Radio Service, 134 Merrimac St., Buffalo, N. Y.

WANTED FOR CASH—Good battery charger, small radios, resistor cords, universal adjustable antenna coils, and various tube types. Send list if you have tubes to sell. Will sell P.A. amplifier with universal output. O.K. Radio Service, Box 482, Okeene, Okla.

FOR SALE—RCA type 955 acorn tube, new, $2.50. Also have 6A7; 25Z5; 25Z6; 75; 6Q7GT; 6SK7GT/G; 26; 12F5GT; 1C5GT/G; 1R5; 80. Want 6, 12, or 32 volt vibrator transformer. Robert Freed, 1140 Fifth Ave., New York 28, N. Y.

WANTED—MI-4036K RCA or velocity mike or Amperite SR80:N studio vel. mike, high imp. types. Clinton Tiggett, 35 P St., S.W., Washington, D. C.

FOR SALE—Meissner analyst #9-1040, never used. Cash only. Kain Radio Service, 34 N. Market, Liberty, Ind.

WANTED—Superior dynamometer or other good make, also Solar QCA condenser analyzer. Have used battery-operated radios for sale. R. W. Seifert, Utica, Minn.

WANTED—0-1 ma. meter; 1A7, 1H5, 12SA7, 7A8 tubes; also Gen. Ind. 2-speed recording and playback unit. White's Radio Service, Box 146, Mansfield, La.

FOR SALE—6-volt mobile amplifier, 76—4—6A6's, 6-volt turntable, make offer. Also DC Pilot Super Wasp receiver with tubes & coils, $5; 5 amp. Tungar bulb, $2. Want T55 and TZ40 tubes. Riley Parsons, Raquette Lake, N. Y.

WANTED for Radio School—Omnigraph and discs; honeycomb coils; Baldwin phones; telegraph relay; coil winder; variometers; tape cutter, or what have you? Juan P. Miller, c/o High School, Grants Pass, Ore.

WANTED—Late model com. receiver and small camera. Carl Morris, EM 1/C, N.C.T.C., Sun Valley, Davisville, R. I.

WANTED—Analyzer and tube tester or combination. Cash. Robert J. Rech, Box 63, Pescadero, Calif.

WANTED—Good DC volt meter, table model radio, or what have you? Have 8-power field glasses in leather case. Walt's Radio Sales & Service, 1801 Illinois Ave., Lansing 6, Mich.

FOR SALE—15" speaker, 1100 ohm field (100 ma.), 8 ohm voice coil, handles 50 watts. $20. Frank P. Dane, 3852 Eagle St., San Diego 3, Calif.

WANTED—Boom mike stand or boom attachment; also all kinds of PA eqpt.; receiving tubes; small radios, and 33-78 turntable. Send list. Ed. Monahan, Shawomet, R. I.

FOR SALE—Clough-Brengle tube checker, model 160. Like new, $40. Rexall Radio Stores, 205 Pearl St., Utica, N. Y.

FOR SALE—Supreme 385 automatic, perfect condition. Walter Jandro, Bldg. 58, Apt. 218, Success Park, Bridgeport 8, Conn.

WANTED—A good signal generator and a set analyzer. Have meters to trade, also a Corona portable typewriter. Sam Berenblum, Greenwich, Conn.

WANTED—AC-DC V-O-M for cash. Describe fully. Steven Palikan, 3826 Elm St., Indiana Harbor, Ind.

FOR SALE—Triplett #1200 V-O-M in need of slight repairs. Has twin meters. Checks up to 1,000 volts and up to 3 megs. Joseph Marsh, 34 Hartwell St., New Brunswick, N. J.

SWAP—35mm. projector, Janette rotary converter, several vols. QST, Pop. Science, Life, Radio Engineering, RCA Radio Course, auto and other radios, etc. Want signal generator, scope, V-O-M, 35mm still camera, 8mm. movie camera and projector, gas-electric generator, etc. Joseph Leeb, 1380 Merriam Ave., New York 52, N. Y.

WANTED—Schematic wiring diagram or operating instructions for Hickok AC49 dynamic tube tester, or for immediately succeeding models. Eliot Greb, 107 W. Blaine St., Seattle 99, Wash.

FOR SALE—Jensen 14" auditorium speaker cone mounted assembly. Can be used as replacement for 18" Jensen speaker. Also G-E ¼ h.p. DC compound wound 1725 rpm motor. M. Rosenblatt, 280 Wadsworth Ave., New York 33, N. Y.

WANTED—Late model emission type battery-operated tube tester and late battery-operated all-wave signal generator. Vernon Kahanek, Route 5, Box 163, Hallettsville, Texas.

MANUALS FOR SALE—Rider's Vol. 1 through 12 in good condition. $75 cash. H. F. DeGarmo, Early, Iowa.

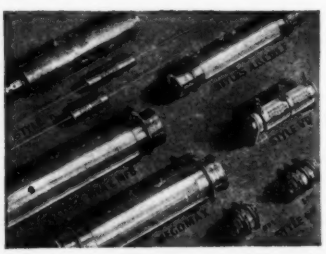
URGENTLY NEEDED—Cash for audolyzer, oscillator, or other test eqpt. Describe fully. C. R. Zellers, 512 So. 2nd St., Wilmington, N. C.

WANTED—Up-to-date point-to-point tester or analyzer; signal generator; intercommunication system and one sub-station. Also offer cash for popular tubes. Newton Radio Sales, Newton, Ill.

URGENTLY NEEDED—RCA chanalyst #162, or Hickok #155 tracometer; RCA voltohmyst #165 or similar unit; Jackson 636 or 637 tube tester; ¼" electric drill. McKerral Radio Service, 211 Garfield, Laramie, Wyo.

WANTED—RCA Jr. voltohmyst #165, Precision 910 or 920. Richard Weidler, 964—59th St., Brooklyn, N. Y.

URGENTLY NEEDED for code class: 50' shielded crystal microphone cable; record player or phonomotor and pick-up (crystal or magnetic); one 0-100 DC Ma.; one 0-5, 0-10, etc. AC voltmeter. Jay White, RR #1, Box 25, Richmond, Indiana.



SPRAGUE KOOLOHM RESISTORS

AT WAR!

If you haven't been hearing much about Sprague Koolohm Resistors lately, it's only because there hasn't been much to say from a civilian standpoint. But there's been plenty happening nevertheless—and all of it has been bad news for the enemy. One after another, Koolohm construction with its famous insulation of heat-proof, moisture-proof flexible ceramic has resulted in higher performance standards for various resistor types—from hermetically-sealed precision meter multipliers, to bobbin-type resistors, and special heavy-duty wirewound types. You'll be pleasantly surprised at the amazing advantages Sprague Koolohms will offer you A.V.D. (after V-Day)!

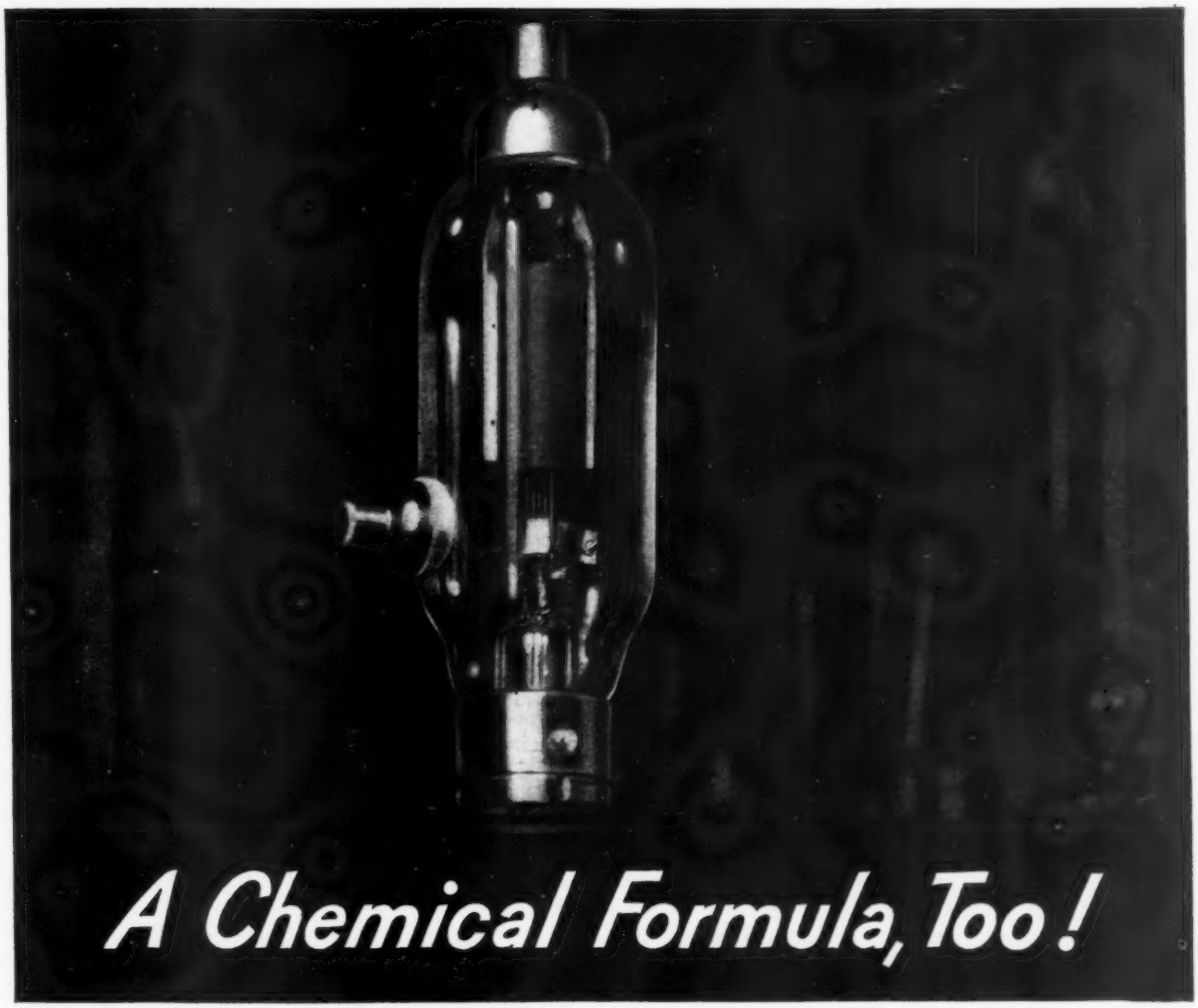
YOUR AD RUN FREE

Send us your Sprague Trading Post advertisement today. We'll be glad to run it free as a part of our special wartime advertising service to the radio profession. "Equipment for Sale" and "Wanted" advertisements of an emergency nature will receive first attention. Different Trading Post ads appear regularly in RADIO RETAILING-TODAY, RADIO SERVICE-DEALER, SERVICE, RADIO NEWS, and RADIO-CRAFT. Please do not specify any particular magazine for your ad. We'll run it in the first available issue that is going to press. Sprague, of course, reserves the right to reject ads which, in our opinion, do not fit in with the spirit of this service.

DEPT. RC-42 SPRAGUE PRODUCTS CO., *North Adams, Mass.*

SPRAGUE CONDENSERS
KOOLOHM RESISTORS

Obviously, Sprague cannot assume any responsibility, or guarantee goods, services, etc., which might be exchanged through the above advertisements



A Chemical Formula, Too!

Chemistry is but one of the many sciences which are collaborating at National Union in the work of producing better electronic tubes for today's vital war assignments. Indeed, our chemists are playing a decisive role in making National Union Tubes *measure up* to the precise standards of scientific instruments.

Thanks to chemical research, we know for example that not only must the formula of a tube's emission coating be *right,* but also the application and processing methods must be rigidly controlled.

To effect such control our chemists, in cooperation with the engineers of our Equipment Division, designed, built and put into production a new type automatic coating machine. Operating in an air-conditioned chamber, this equipment provides exact control of both the coating operation and the chemical processing of the emission coating—free from all extraneous elements.

When making post-war plans, keep in mind that tube manufacture *is* a many-sided scientific business. To get the tubes and up-to-the-minute service data you need—*count on* National Union.

NATIONAL UNION RADIO CORPORATION, NEWARK, N. J.
Factories: Newark and Maplewood, N.J., Lansdale and Robesonia, Pa.

NATIONAL UNION
RADIO AND ELECTRONIC TUBES

Transmitting, Cathode Ray, Receiving, Special Purpose Tubes • Condensers • Volume Controls • Photo Electric Cells • Panel Lamps • Flashlight Bulbs

MT. CARMEL WHERE ELECTRONICS IS KING

Keen Eyes and Sensitive Fingers: Here's skill—plus imagination! A typical scene at Meissner's Mt. Carmel plant as vital war supplies, precision-made in every detail, are kept moving to world battle fronts.

Can He Qualify? Even in wartime, Meissner prides itself on its "hand-picked" personnel. Here Personnel Manager White is interviewing a promising applicant. (See main caption at right.)

Your Guarantee of Perfection: Down through the years, the Meissner name has come to stand for the ultimate in radio quality. These two, along with hundreds of other experienced technicians, are very good "reasons why!"

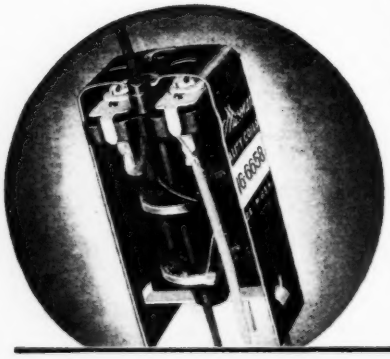
Precision Family: It is said that Mt. Carmel, Illinois, has more electronics technicians per thousand population than any other city on earth. Shown here are five of the six members of the Collins family — one of the many families helping to make the delicate, sensitive equipment for which Meissner is famous.

PERSONNEL? Here It's PRECISION-EL!

Mt. Carmel, Illinois, (population 7,000) is famous for two things: music and electronics. The first reputation is based on its top-flight civic and high school music groups — on such outstanding home-town "products" as Howard Barlow, renowned symphony conductor. The reputation for great electronics ability centers around the humming Meissner plant — where scores of employes have spent their entire working lifetimes on the exacting requirements of Meissner's "Precision-Built" line. Their flying fingers, now assigned to war orders of tremendous strategic importance, long ago lifted them above mere "personnel" into the radio industry's highest honor—"PRECISION-EL!"

Ready for Delivery

Good news! You can now obtain a quantity of the highly popular Meissner "Plastic" I. F. Transformers. As you know, these are particularly suitable for use in small receivers—where space is at a premium, yet superior performance is required. Meissner "Plastic" I. F. Transformers are famous for remarkable stability, high gain, wide range and double tuning. Typical of Meissner precision building, they are only 1¼" square x 2½", yet are not affected by temperature, humidity, or vibration. Specially served Litz wire! One-piece molded plastic coil-form and trimmer base! Order at once for prompt service.



MEISSNER

MANUFACTURING COMPANY • MT. CARMEL, ILL.

ADVANCED ELECTRONIC RESEARCH AND MANUFACTURE

Post-War Radio Angles

. . . . Revolutionary changes in Radio is a promise of post-war developments . . . .

HUGO GERNSBACK

WHILE the general calendar shows that this is the year 1944, the technological calendar reads 1960. Many authorities have stated this, because war developments have compressed into the past few years fifteen years of technical advance. In this war, more so than in any other, the impact of war developments on established trends has been terrific and breathtaking, so much so that when the final story will be told, after the war ends, even technicians in many different lines of endeavor are in for a great deal of astonishment.

The past few years have witnessed an avalanche of secret developments, which cannot be told for security reasons till peace is once more established, but it appears certain now that radio, to mention only one of the arts, will be completely revolutionized. In many respects even radio technicians will have to learn radio all over again.

Many of the arts and sciences have made so many and such great advances that at the end of the war we will have a huge jig-saw puzzle where advances in one art can be dove-tailed into other arts for further advances. Indeed the end is not in sight. The few remarks that follow do not by any means show what is in store, because many secret radio developments cannot be mentioned now. We therefore can only discuss a few subjects here.

Take MAGNESIUM for instance. At one time this metal was in the precious class just as aluminum also was at one time. Huge production, which lifted aluminum out of the precious-class metals, has now also lifted magnesium out of that class. It will, in the post-war period, remain in the big production sphere. Magnesium is not only much lighter than aluminum, but it also has other important properties. Many people, including technicians, do not know that in battery manufacture we can replace the zinc element with magnesium. When we do this something extraordinary happens—the voltage of the electric cell in which it is used appreciates considerably. Thus an ordinary dry cell, using zinc, which normally is rated at 1½ volts, rises to almost 2¼ volts with magnesium. That means that where formerly two cells were used in a flash-light battery, we can now use either a single cell and get almost as much light as we got from two cells before, or we can substitute a higher voltage bulb and get practically double the amount of light. In "B" batteries, such as used in portables, if made with magnesium elements, we get nearly 67½ volts, where formerly we only had 45 volts. That means that the size of the portable can be reduced; or we can save space and yet get a greater voltage for the same volume of the zinc type battery.

Magnesium could not be used successfully heretofore on account of its high cost. There are also a few other technical details to be overcome before magnesium can be used universally in dry cells, but I believe that by the time the war is over, this difficulty will also have been overcome. Where a few ounces of weight is a matter of importance, magnesium chasses for radio sets will probably be used in lieu of steel or aluminum, which were common in pre-war radios.

BONDED WOODS AND BONDED PAPERS—now processed electronically—will also make their appearance in the post-war radio set. These bonded and plasticized woods and papers are often stronger than steel. They can be made in every shape and color and are water and moisture proof. Neither will they warp, even under extreme temperatures. While regulation plastics will be used for radio cabinets, bonded plasticized wood and paper housings, no doubt, will be used more than the plastics themselves, due to the lower cost of the former. Plasticized wood and paper can also be fire-proofed and these new materials will in turn make excellent chasses, which will frequently replace the metal chassis. The advantage here is that short circuits, which often occur with the metal chassis, will be done away with and better insulation for some of the radio components will be gained. There are a number of other minor uses for bonded wood and papers in radio sets and the radio art in general.

(Continued on page 299)

Radio Thirty-Five Years Ago

In Gernsback Publications

FROM the February, 1909 issue of MODERN ELECTRICS:

The High Tension Transformer, by *M. A. Devinv.*

Umbrella Antenna, by a *Berlin Correspondent.*

Tuned Wireless Telegraphy (account of the Marconi Wireless Telegraph Company introducing their new multiple tuner).

Operator Jack Binns' Wireless Log (a full account by Binns of radio fame of the steamship *Republic* shipwreck).

Navigation by Wireless, by *Scientist M. Bouquet de La Grye.*

THE WIRELESS SCREECH (humorous 2-page article, including "Wireless on Mars," etc.).

Development in Wireless Telephony, by *William Maver, Jr.*

HUGO GERNSBACK
Founder

Modern Electrics	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Radio-Craft	1929
Short-Wave Craft	1930
Wireless Association of America	1908

Wireless Telegraph Contest (showing photographs of the *then* wireless amateurs in great profusion).

A Simple Antenna Switch, by *A. C. Austin, Jr.*

"Wireless Registry," giving call letters of wireless amateurs. The first such directory in radio history.

The Advertising Section also showed the first Wave Meter to be advertised anywhere. It was manufactured by the Radio Telephone Company (DeForest System) of New York.

Radio-Electronics

Items Interesting

SOUND-POWERED telephones, of the type used before the invention of the carbon microphone, are proving themselves as useful as the latest electronic gadgets, the War Department was advised last month by Colonel R. B. H. Rockwell, just back from a South Sea island where he had served as division signal officer.

Freedom from cumbersome batteries, simplicity and reliability are the chief advantages of the sound-powered phone, which receives its power from the human voice. Modern discoveries in magnetic materials, together with skilled design, has produced an instrument incomparably better than the ancient Alexander Graham Bell telephone used on the first voice-powered lines. It is capable of carrying its message as far as ten miles under favorable conditions and has a range of five miles under almost any circumstances.

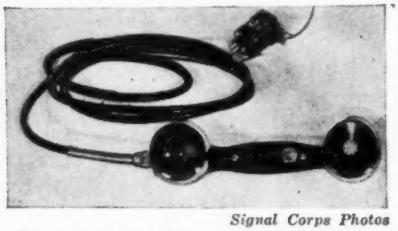
The equipment was found particularly advantageous on Guadalcanal because of the lack of batteries, which have been found susceptible to deterioration from the humidity and dampness of the South Pacific. In addition, it is considerably smaller, more compact and more durable than battery-powered telephones. In size and appearance it is similar to the hand set in use in American homes. "Calling up" is accomplished merely by whistling into the transmitter.

Colonel Rockwell explained that the orally-powered telephone equipment was installed on Guadalcanal for fire control of Infantry mortars and within Infantry companies, since at night all men were instructed to remain in their fox holes. Orders had been issued that anyone moving about after dark was to be fired on.

Referring to the part played by the Signal Corps on the South Pacific island, Colonel Rockwell said, "Our experience on Guadalcanal demonstrated that signal communications troops must be at least as well seasoned as combat troops, since the installation, operation and maintenance of communications goes on continuously."

Laying wire on Guadalcanal was described by Colonel Rockwell as "a man-size job in itself without considering Japanese snipers who, at times, would harass our linemen. Our linemen always operated in teams, armed with rifles or sub-machine guns to protect themselves. Despite these difficulties, an excellent communication system was maintained, even during the most critical moments of the struggle.

"For the most part," he continued, "they were forced to work in the daytime. It was almost impossible to identify and follow wire circuits at night. No lights were permitted. In the front lines—which were not like our usual conception of front lines, but fox holes dug several yards apart along the front—anything that moved at night was almost sure to be fired on by friend and foe alike."



Signal Corps Photos

This—and connecting wires—is all there is to the Army's new telephone.

RADIO WJZ, pioneer American broadcasting station, entered a new phase of its life with its removal from Bound Brook to Lodi, New Jersey, at the beginning of the year. The removal from Bound Brook was dictated by the necessities of war, the Government having found it necessary to take over the buildings and land formerly occupied by the station.

Moving the 45 miles to Lodi was an engineering feat of the first order, as broadcasts were not to be interrupted during the process. The first step was to carry on with a temporary transmitter from Kearney, New Jersey, while the 50,000-watt transmitter was moved to the new location and set up.

Chief feat was the moving of the 640-foot steel tower, which was divided into sections and transported on trucks, to be bolted together again at its new home. Removal arrangements all dovetailed perfectly, and when WJZ listeners were asked to stand by at 6:00 P.M. on January first, there was no more than the usual "short-pause-for-station-announcement" when the stronger voice of the 50,000-watter began pounding in.

The site at Lodi was chosen because of its proximity to the important New York City metropolitan area, but shortly after going on the air January first, letters received by the station proved that an all-round improvement had taken place, and that the station was putting a good signal into places formerly covered only spottily. WJZ engineers attribute this to the swampy nature of the soil at the new location. While at Bound Brook, roughly half a million people were within an area into which WJZ put a signal of more than 50 millivolts. Now there are more than eight million people within the 50-millivolt area, an important increase.

WIRED wireless was advocated as a solution to problems of interference and poor reception by Sir Robert Watson-Watt, pioneer of radio-location, in an address before the British Association last month.

Following Captain Eckersley, long known as Chief Engineer of the BBC, who has long been a proponent of the wired method, he advocated four radio freedoms for the British listener: freedom from interference; freedom from distortion; freedom of choice, and freedom from distraction. He suggested that every listener should have six channels available. The regular broadcast stations could still be used in conjunction with the wired system, to provide entertainment for listeners in rural areas not served by electric or telephone lines.

Opponents of the plan point out that its adoption would cause broadcast receivers to disappear, due to the line competition. This, they feel, would harm British radio business, which depends on broadcast receivers for 80% of its income. Further, a wired-wireless system is too dangerous a weapon to place in the hands of a possible enemy of civil liberties, under possible post-war conditions. It is pointed out that Hitler made excellent use of the *"Volksempfänger,"* which gave him the advantages of a watertight distribution system for directing public opinion. Another point motivating the opposition is an inability to shake itself free from the suspicion that the proponents are entirely disinterested. It is suggested that the BBC, "remembering with acute discomfort the embarrassment caused by competitive broadcasting from Radio Normandie and Luxembourg, would welcome anything that removed a threat to its monopoly." Possibly a great deal of the enthusiasm behind the proposed wire system is due not as much to solicitude for the listener as to fear of foreign competition.

●

PAYROLLS in radio broadcasting lead those of any United States industry, a comparison of figures shows. "Radio Employment and Compensation Data," issued last month by the FCC, indicates that employees of 10 networks and 815 stations received an average of $49.50 weekly. With executives and employees lumped together, the average is $55.75. There is a wide range of wage scales, running from an average of $146.39 weekly for "general managerial" skill to $25.17 for "clerical" workers.

The figures given are said to average higher than those paid in any other industry in the United States. The averages indicate that weekly compensation has increase 6.6% over last week, balancing in large part the increase in the employees' living costs during that period.

Another attractive feature of this branch of radio is that the industry is bound to expand rather than contract after the war.

Monthly Review

to the Technician

CONVERSION to FM transmission of all but clear-channel broadcast stations was predicted last month by John V. L. Hogan, veteran radio engineer and pioneer of high-fidelity broadcasting. Shifting the vast majority of stations to FM, he said, would relieve congestion in the present AM band and make possible the allotment of additional clear channels.

The AM stations, Mr. Hogan believed, would serve those areas too far from populous centers to benefit from FM, while in large cities FM would supply practically all the average listener's entertainment.

Mr. Hogan's prediction was made during an appearance before the Senate Interstate Commerce Committee, to answer questions in the capacity of an authority on radio broadcast.

●

DEFINITE confirmation of the radio control feature of the new Nazi gliders is found in a recent eye-witness statement by British seamen who were attacked with the so-called "secret weapon."

The report, which came from London last month, describes the fire-trailing winged bombs as "something out of a Martian invasion." One of the gunnery officers, Robert Daley, states definitely that "they made the gliders turn corners." According to his statement, the flying bombs were kept on the level from the time of their release till near the ships, when they were made to dive at the vessels. In spite of the horizontal and vertical control, said Daley, the Nazis must have been poor marksmen, as no hits were scored. One, however, might have hit his freighter, but was shot down a short distance away.

The glide-bombs were all equipped with brilliant red lights, though the attack was made in daylight. These were apparently to facilitate guiding them at night, thought Mr. Daley. *Radio-Craft* believes that these red lights may be vastly more significant than the sailor believes, and respectfully suggests they may have some connection with photo-control devices, possibly colored to work in the fog or mist, so common in the North Sea and similar areas.

●

NEW SHORTWAVE broadcast transmitters WOOC and WOOW which are the first to be installed under the OWI's program to expand U. S. international broadcasting facilities, began operations over the week-end, according to E. K. Cohan, CBS director of engineering. The transmitters are on the former site of WABC, in New Jersey.

Work on the ultra-modern transmitters was begun last July on the New Jersey grounds. The site was chosen by the OWI because of its ideal facilities, including underground conduits for power and radio circuits, and many acres of property completely cleared of trees and other obstructions, factors of great value in the construction and operation of a radio station.

Programs in English, German, Italian, French, Spanish, Serbo-Croatian, Polish, Dutch, Czech and Albanian will be beamed to all of Europe over the two ultra-modern transmitters for 16 hours daily, starting at 10:45 a.m.

Hours of operation will be increased to 20 hours daily in a few weeks, according to the OWI. Columbia's overseas engineering operations are under the general direction of Guy C. Hutcheson.

●

EFFECTIVE relief for radio tube shortages is foreshadowed in the WPB program of tube production for the first quarter of 1944.

The plan calls for the manufacture of at least 4,500,000 radio tubes. These will largely be in the "critical" types, such as the 12SA7, 12SQ7, 12SK7, 50L6, 35Z5, 35L6 and the battery types 1H5 and 1A7, as well as the standard 80, demand for which has far outrun production.

These tubes (with the presumable exception of the 80) will all be put out in the "GTG" type. All are to carry the "MR" (maintenance and repair) mark, which renders them non-divertible to military use.

While this program may not completely solve the home receiver program, points out WPB, it is designed to put the greatest number of sets back into service for the least number of tubes manufactured, and should result in restoring thousands of receivers to playing condition.

Cooperation of radio servicemen and dealers is expected in seeing that these tubes first reach those householders who have no sets in operation due to lack of tubes.

CHEAPER television by a new projection system which may cut the cost of television receivers to a fraction of that of conventional types, was revealed last month by Emerson Radio and Phonograph Corporation. A combination of former television technique with that of the moving picture is planned.

The television instrument, planned by Emerson engineers, approximately 18 inches wide and 14 inches high, will be a complete radio and television unit employing a three-inch cathode ray tube. The television image will be enlarged and projected to 15- by 20-inch proportions with a motion picture screen, by means of a lens system made of plastics. The brilliance will equal that of home movies.

"It is our plan to feature these sets for no more than $150 as compared with the pre-war average price of $500 to $800 for the 12-inch image type of receiver," said Mr. Abrams, president of the corporation, addressing a company engineering conference.

"In the latest pre-war developments of television," he said, "there appeared three basic types. The first of these was the small tube, direct-viewed, compact model employing the five-inch cathode ray tube and yielding a 3-inch by 3¾ inch image. Later, the five-inch tube was enhanced by means of an intensifier connection but even this failed to overcome the small size and poor definitions inherent in such presentation. Aside from the low cost, the only advantage of such receivers was their compact table model type of design.

"The remaining two types of receivers employed a 12-inch cathode ray tube. Because of this bulk, opinions differed on how the 12-inch tube should be viewed. Some manufacturers produced receivers in which the tube was observed directly while others chose to expose the image indirectly on a mirror attached to the tilted lid of the cabinet. In either case the picture size was about 7½ by 9¾ inches. For most practical purposes the brilliance of the picture was satisfactory, but the size was inadequate for convenient observation by more than a few persons gathered around the console. The picture actually looked smaller than those dimensions because of the disproportionately large console required to house the great length. Moreover, the bulky cabinets were costly and took up valuable space in the home. Emerson's design will completely overcome all such disadvantages."

Appearance of the proposed projection teleceptors, as conceived by Emerson artists. Viewing screen may be mounted on the lid for easy focusing, or quite outside the receiver.

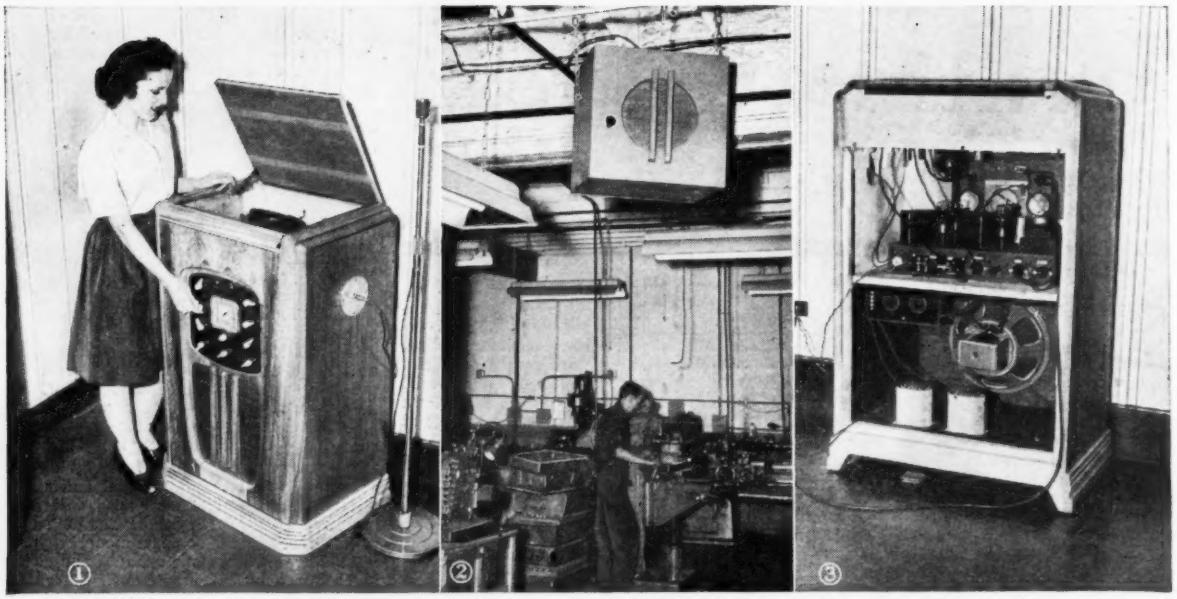


Photo 1—Main station—plus operator-announcer. 2—This is certainly true industrial music. 3—Rear view. Dials are volume controls.

MUSIC IN INDUSTRY

Efficiently-Planned Morale-Builder

By WILLIAM H. HUTTER*

WITH interest in industrial music rising on an ascending scale, and with the demands of the world conflict focusing sharp attention on the increased production music provides, the management of the Oscar W. Hedstrom Corporation determined to give their employees the finest available broadcasting industrial unit.

The author, who designed and made the installation, was, and is, convinced that each industrial unit has characteristic peculiarities that must be taken into account before the work is begun. And here, too, the installation was tailored to fit the need.

Firstly, an analysis of the square feet to be covered must be made. Then, the noise level determined. This is essential where the modern war plant engages in a variety of activity and the corresponding noise may vary from a sharp staccato blast to a penetrating continuous din.

From this data you are then able to determine how many speakers to use and exactly where to place them, making certain to place them directionally so that they, in every instance, override the shop noise.

Where telephone lines are used, as was done on the Hedstrom installation, they must be measured and equalized so that all frequencies in the musical band are equally attenuated. This makes for a maximum of quality reception with a minimum of distortion.

The physical factory properties of the Hedstrom Corporation are divided into four buildings: the main plant, a post-war planning building about 400 feet west of the headquarters building; plant No. 2 which is one-half mile due south and plant No. 5 which is one and one-half miles away in telephone line distance. The post-war building works directly off the headquarters central location, plant No. 2 required no equalization, while in equalizing No. 5 it was necessary to knock the line down to a loss of 28 db.'s. The lines from plant 2 and plant 5 are within 1 db. plus or minus from 50 cycles to 5,000 cycles, which in effect, makes it a high grade transmission line.

The short telephone line is 500 ohms, while the longer line to plant 5 was stepped down to 125 ohms at the main plant for better equalization and back to 600 ohms at the place of output.

At the terminal end of the telephone lines are two booster amplifiers consisting of two stages, each having an over-all gain of 40 db.'s, with a power output of fifteen watts at 2 per cent distortion. Each booster amplifier is equipped with volume, bass and treble controls to further balance tone and the volume necessary for the characteristics of the particular location.

The master console from which the broadcasting originates, consists of a turntable 78 or 33⅓ R.P.M., using a high fidelity crystal pick-up for play-back, the weight of which is just under 2 ounces. The weight of the pick-up was advisedly kept at a minimum because of a stable heavy cabinet construction and a full-floating mounting shelf.

A cutter is used for making records, which are in many instances mailed to former Hedstrom employees in the service. Present workers also find a variety of uses for the home-made records, but they are usually made for mailing to relatives and friends in the armed forces. The microphone shown in the photograph is of high-fidelity crystal construction, and is used for broadcasting and for radio re-broadcasting.

It was felt inadvisable to use a radio in the console itself because of the rapid obsolesence of radio design. Instead, the program on the air is picked up from an external unit by the "mike" and sent out over the console unit to the four plants.

This entire system, as it now operates, embodies a master amplifier with a power output of 25 watts at 5 per cent distortion. The microphone input into the amplifier has an additional stage of amplification through a 6SF5 tube. The pick-up feeds into a 6J5 tube followed by a push-pull stage of 6L6's.

The circuit utilizes a bass boost. The transformer design is such as to give a rising tendency with its peak at 4,000 cycles. This rising characteristic at high frequencies takes care of sibilants, makes for a good understanding of speech and helps to eliminate noise penetration.

The output transformer of the amplifier uses a 1 ohm and a 500 ohm winding. The 1 ohm line feeds to six speakers in parallel, including the one in the console, and the 500 winding feeds to the input of two 500 H pads, the other side of which feeds the two telephone No. 111C transformers.

The control panel has been so laid out that it facilitates the monitoring of all programs (riding gain), since the telephone company insists upon a level of 8 T. U.'s being maintained at all times. This level is sustained by the use of a master volume control and a 500 ohm output meter which is directly connected across the 500 ohm winding of the output transformer.

Base and treble controls are provided and are used to attenuate the variation of base and treble crescendos of the more than 300 records that are now in the Hedstrom library. A strategically-placed location switch enables the operator to cut off various locations at her discretion when the music is not desired at a particular plant at the time of its broadcast.

After a scientifically thorough noise analysis of sound levels had been made at the contemplated speaker locations, the speaker design began to take shape in the author's mind. Experience has taught that the efficacy of music is as good or as bad as those

(Continued on page 301)

*Consulting Sound Engineer, Oscar W. Hedstrom Corp.

ELECTRONICS *in* 1944

Radio-electronics has made startling strides during 1943. RCA's president, Mr. Sarnoff, believes that even more striking advances will be made in the coming year and those following.

By DAVID SARNOFF*

RADIO activity in research, engineering, communication and manufacturing during 1943 may be summed up in one objective: Win the War! Although wartime secrecy imposes limitations, the end of the year affords an appropriate opportunity to gauge radio's vital role in the world today, and to measure the significance of wartime developments as they may fit into the pattern of the future.

Today, on the wings of the airplane, Victory soars. On the waves of radio, Freedom sends its heartening message around the world. Science triumphant has given winged Victory indomitable power. There is no direct clue, however, to reveal how long and difficult the march to final victory will be. Until the goal is reached, there must be no letdown in the effort to win the war.

The American radio industry is breaking all records in production and communication. As the New Year dawns, the ether pulses with new vigor. Micro-waves accomplish new wonders. Daily, 400,000 radio-electron tubes are manufactured. Every hour of the day and night, all America is informed by up-to-the-minute broadcasts on the progress of the war. At the same time, short-wave broadcasters are reaching every land throughout the world regardless of enemy restrictions. Tons and tons of apparatus are sent into combat every week. Miles and miles of transoceanic radiotelegraph circuits are vibrant with urgent dispatches, news and communiqués. Messages are flashed by automatic high-speed machines at the rate of 600 words a minute.

A radio flash from a walkie-talkie in a foxhole, or from a handie-talkie on a beachhead, may well be the signal of victory. A radio flash from the cockpit of a fighter plane, or from a rubber life-raft, may turn the tide of a battle, or save the lives of struggling men. Radio's record for 1943 attests the triumphs of the deft fingers that make radio tubes; of the hand that manipulates a soldering iron on the assembly line, or the skill of the tester who declares the complete apparatus ready to enter the fight.

AMERICAN RADIO FIRE-TESTED

American-built radios have been under fire now for more than two years. Within that period home-radios in the United States have been used as never before as a source of news and entertainment. A home without a radio is out of tune with the world. Americans everywhere have an ear to the battlefronts. There are 60,000,000 receiving sets; 31,000,000 "radio families"; 900 broadcasting stations; 14 American international short-wave transmitters; millions and millions of radio-electron tubes glow in the service of the nation.

The postwar era will bring many challenges and problems to test American leadership and enterprise. Industry must be prepared to reconvert as quickly as possible from war to peace, yet without the slightest neglect or relaxation in the total war-effort.

Radio as an industry is fortunate to have television as a postwar development of great promise and popular appeal, able to open a new era in service to the public.

There should be no expectation, however, that when the war ends the air will be adapted overnight to television. It will require from 3 to 6 months to get the machinery in operation to resume the manufacture of civilian broadcast receivers. It may require a year after approval of standards and full authorization of commercialization of television broadcasting by the Federal Communications Commission before television sets are available within the price range from $200 to $300. Production of television receivers is not the only task. Television transmitters must be erected. Interesting programs have to be planned. Automatic radio relay stations must be built to link key cities into a network.

Alongside of television, F.M., or frequency modulation on ultra-short waves, holds great promise of becoming an added feature in broadcasting. Even now F.M. carries the sound part of television. In both television and F.M., much scientific progress has been made in connection with the application of radio to the war. The home radio instrument of the future will be a combination television and sound-receiver incorporating F.M. and phonograph.

Outside the realm of radio communication, the application of radiothermics—or radio heating—is finding widely extended use in industry. The use of high-frequency waves for heating is a wartime development of no small achievement. It is accelerating and increasing the efficiency of numerous industrial processes.

THE FUTURE OF RADIO

Thus, the future of radio is an ever-increasing circle within whose orbit new peacetime services are being evolved through wartime research and engineering. As keys to the microwave spectrum, more powerful electron tubes are opening the domain of tiny wavelengths, which possess unlimited possibilities in radio and its related fields of electronics, television, radiothermics, supersonics and electron microscopy.

Because of spectacular wartime developments, radio apparatus will be adapted for collision prevention to aircraft, ships, railroads and possibly automobiles. All this will be part of the new service of radio in an era of sight control made possible by the development of electron tubes in the field of microwaves.

As new electron tubes always serve as keys to major advances, so in broadcast reception, new and tiny tubes—smaller than acorns—may introduce "personalized" radio. Small, compact receivers, and even transmitters may be built in a little case that will slip into a pocket. The uses to which such "stations" may be put gives the imagination much to play upon.

All these new developments will not be realized in 1944, but with 1944 as the year of expected decision in the European war, they will date from it, as radio broadcasting dated from 1919.

The new ideas, tools and instruments of progress that emerge from the war may well give us 1960 radio in 1950. War shrinks the lapse of time between invention and its practical use. The merit of a discovery is quickly appraised and harnessed.

THE COST OF OUR PROGRESS

While we can see all these signs of progress, we must not lose sight of the losses suffered to the world through the casualties of battle. The boy who fell in the jungles of Guadalcanal, on the sands of Africa, on the road to Rome, who vanished in the Atlantic or Pacific or parachuted into the realm of missing warriors, may well have carried with him a revolutionary idea. At the year-end, when we review a year of war, we wonder what might have been the fate of wireless had war taken the lives of such men as Maxwell, Hertz, Marconi, De-Forest, Armstrong, Alexanderson and Zworykin, in their youth.

But the young men, lost to the world and to science in this war, have, in their supreme sacrifice, made it possible for the civilized world to progress; they have contributed far more than invention. They have made future invention possible by the defense of a civilization in which men can think, work and achieve for the welfare of mankind under freedom and justice.

We may look forward to 1944 with high hopes, bulwarked by a determination never to break faith with those who have fallen, or with those who are marching, with the Stars and Stripes, on the bomb-infested road to Victory.

* President, Radio Corporation of America.

New Electronic GUN DIRECTOR

(Cover Feature)

Gun-pointers are on the job, but aiming is automatic.

AN epoch-making development in Army ordnance was shown to newsmen and others recently when the Army and Bell Telephone Laboratories jointly demonstrated the Electrical Gun-Director on the Laboratories Grounds at Murray Hill, New Jersey. As an Army plane overhead simulated a bombing run, observers noted that four guns of an anti-aircraft battery were following the plane, without manual operation by their gunners, and that they were trained, not at the plane but at a point ahead of and above it. Seated at a sizable metal box mounted on the pedestal, observers with eyes glued to telescopes kept the cross-hairs trained on the plane. Both telescopes turned vertically; and also along with the box and the observers, they turned horizontally. By another instrument, the plane's distance was measured. After the plane had been "tracked" for a few seconds, the fire-control officer gave the command "Fire!"; the shells for each gun were pulled out of their individual fuse-setters, where their burst had been timed under the control of the Director; immediately and automatically rammed home and the breeches closed.

To the Army's regret, the guns were not fired, but if they had been the shells would have travelled on a path converging with that of the plane, and would have exploded within lethal range of it. Officers who had seen the set-up used against a towed target said that instead of an occasional hit, the target sleeve was invariably torn to ribbons by a salvo of four guns.

How the Electrical Director works can be explained by starting with the artillery-man's problem of aiming a gun at a fixed visible target, say a captive balloon. The gunner must know the direction and distance of the target, and also the muzzle velocity of the shell, the direction and velocity of the wind, and the density of the air. Using ballistic tables, he finds a direction and elevation to point the gun, and the setting of the fuse. These tables, converted into electrical terms for a particular gun, are built into the Electrical Director, so that if its telescopes and range finder are pointed at a fixed target, the battery is automatically aimed in the right direction.

If, however, the target is an airplane in flight, consideration must be given to the distance and course which it will travel during the several seconds while the shell itself is in flight. As the telescopes follow the plane, the Electrical Director gathers information from which it predicts just where its target will be when the projectile reaches it, assuming that the plane flies a straight course as precision bombers must. The Director then selects, with the aid of its built-in ballistic tables, a direction and angle of fire, and a fuse setting, which brings the shell to its rendezvous with the plane and explodes it there.

Referring to Fig. 1, it is easy to follow the details of the Electronic Gun Director, as well as to understand all the factors which it must take into account.

An enemy plane (1) looms in sight. The crews of the tracker (6) and of the height finder (3) spot the target and follow it in its flight. The computer (7) of the electrical director instantly measures the position of the target and then predicts where the anti-aircraft gun (5) is to be aimed and how the fuse of the shell is to be set so that the shell will burst in the path of the plane at the predicted position (4).

The electrical information derived by the computer is translated into mechanical movement at the gun to swing its muzzle automatically to the correct horizontal and vertical angle to score a hit. Not only must the computer make its calculations continuously during the entire period the target is being tracked, but it must make constant and instantaneous corrections for a number of reasons.

The time of flight of the shell (a) to the predicted position of the target (4), is dependent upon the muzzle velocity of the gun (b), which in turn is governed by the temperature of the powder and the number of times the piece has been fired. The path of the shell is also influenced by its drift (c) which is the spin caused by the rifling of the gun, curving the shell to the right. At the same time the pull of gravity (d) deflects the shell downward, and the varying density of the air (e) slows down the projectile more or less, while the direction and the velocity of the wind (f) either retards or pushes the shell ahead or to one side. To add to the complications of the problem, the difference in the location of the tracker and the gun (g) must also be taken into account.

In the art of ranging on a moving object, the Electrical Director represents a considerable advance in several particulars. For one, it has solved the difficult problem of compensating for the errors introduced by the human element. There is a natural tendency for the observers to permit the target to stray from the cross-hairs in the telescopes. Realizing that this has occurred, the observer attempts a quick recovery which may be interpreted as a change in the speed of the target. If this information were used, the gun would quickly change its lead to fit the false rate of speed. Engineers have long been familiar with electrical networks for telephone systems, so they invented a brand new one by which the momentary fluctuations are averaged out,

(Continued on page 301)

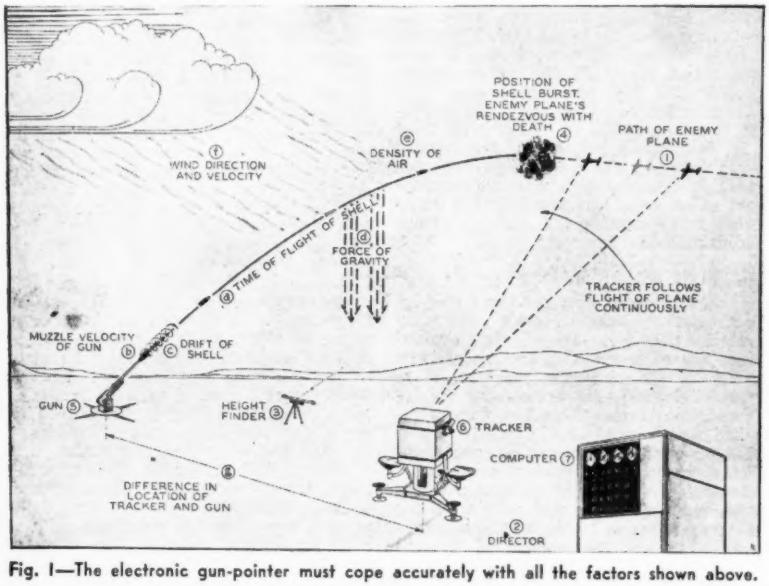

POSITION OF SHELL BURST, ENEMY PLANE'S RENDEZVOUS WITH DEATH ④
PATH OF ENEMY PLANE ①
ⓕ WIND DIRECTION AND VELOCITY
ⓔ DENSITY OF AIR
ⓓ FORCE OF GRAVITY
ⓐ TIME OF FLIGHT OF SHELL
TRACKER FOLLOWS FLIGHT OF PLANE CONTINUOUSLY
MUZZLE VELOCITY OF GUN ⓑ
ⓒ DRIFT OF SHELL
GUN ⑤
HEIGHT FINDER ③
ⓖ DIFFERENCE IN LOCATION OF TRACKER AND GUN
⑥ TRACKER
COMPUTER ⑦
② DIRECTOR

Fig. 1—The electronic gun-pointer must cope accurately with all the factors shown above.

1—Portable radio of the type used in South Pacific landing operations. 2—The jeep station combines great mobility with longer range than afforded by pack sets. 3—Latest and smallest transceiver, the guidon radio.

U. S. Navy Photo *Signal Corps Photos*

Electronics in Modern Warfare

By TED POWELL

THIS paper is severely limited in the nature and detail of the information it contains because of wartime censorship. Certain military electronics equipment may not even be mentioned by name now in order that Axis agents may not pick up useful leads and scraps of information which may total up sufficiently to become of military importance. It has been written in order to emphasize the vast importance of electronics in this war of specialists, machines and production. It is a war that has developed into a bloody and ruthless struggle of industrial giants fought on a world-wide battle front but which will eventually be won on the laboratory bench, the drafting table and the production line.

Out of all the brutality and tragedy that is World War II, there have emerged many blessings both technical and social. Born of a desperate necessity, they have crammed a generation of progress into the relatively short span of a four-year planetary war. Perhaps the most significant of these developments is the rapid expansion of the electronics fields.

COMMUNICATION

The most obvious application of electronics to wartime use is in the problem of high-speed and mobile communications equipment. The mobility of mechanized armies, the great speed and range of the airplane, the guerrilla nature of modern naval warfare, the tremendous amounts of convoy-borne war materiel required by the modern fighting man and the world-wide extent of the conflict have all combined to make communications an extremely vital factor in modern war. This is particularly true where amphibious campaigns must be undertaken and the complete integration and coordination of land, sea and air forces is absolutely essential if materiel and manpower losses are to be kept at a minimum.

The widespread use of such communications equipment was made imperative by the very nature of modern combat techniques as first introduced by the Germans in the forests and plains of Poland. Oddly enough, such battle innovations bear a strange parallel to modern athletic games. Knowing Nazi methods, this may be more than mere coincidence. At any rate, they pointedly illustrate the necessity for elaborate communications equipment in modern war.

The finest analogy of all is the gridiron game. It began as a slow and ponderous tug-of-war affair in which massed manpower was hurled at a calculated weak spot in the opposing defense, in turn met by a converging mass of defensive manpower; opened up somewhat with the development of passing, the reverse play and the spinner; became an open and technical game with the introduction of a "razzle-dazzle" technique of intricate ball-handling and manpower shifting which kept the opposing defense unbalanced and decentralized; and finally, evolved into the modern bewildering, intricate, wide-open, mobile, high-speed "spread-the-defense" type of game.

It now employs highly trained "specialist" backs and picked field generals who skillfully mix deceptive plays and tactics to suit playing conditions and send crack backs off on swiftly executed intricate plays with little direct protection much of the time. These backs hurtle through gaping "sucker" holes in a scattered and bewildered defense line, while fast linemen and blocking backs move downfield behind the opposing line to scatter and cut down the secondary defense to allow the backs to break away for long and spectacular gains.

The obvious and significant point involved here is the fact that such play calls for intense specialist training and the use of elaborate signalling systems on the part of both the defense and the offense.

FOOTBALL AND THE BLITZ

This sports analogy closely parallels the development of modern war tactics and the closing sentences breathe the very essence of the Nazi panzer attack.

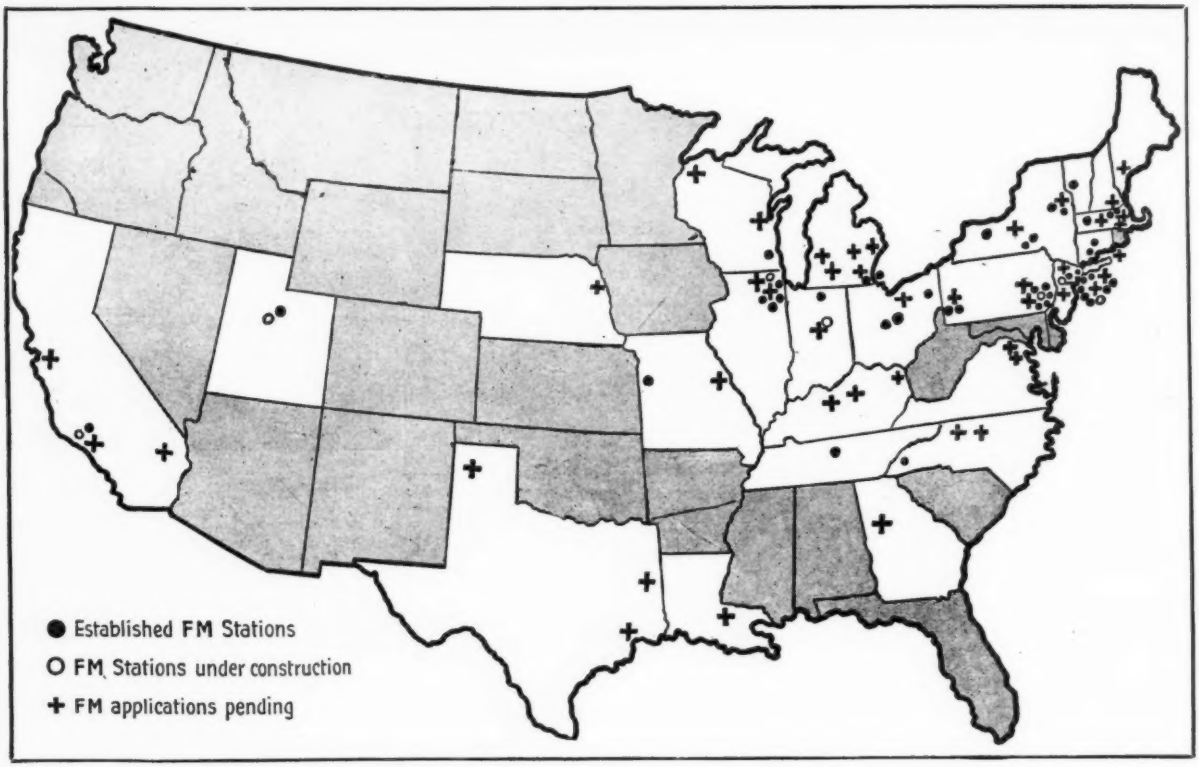
Thus in World War I and in previous wars, the general tactics consisted of the hurling of massed armies at calculated weak spots in the enemy lines which in turn were met by counter-attacking waves of massed manpower; changed somewhat with the advent of the airplane and some mechanization; expanded further by the application of the German military experts' philosophy of "outflank, envelop and destroy" and the "double-envelopment" method of attack; "opened up" still further with early American and Russian experiments with paratroopers and further mechanization; brought up to date by the prophetic envisionment of the modern streamlined "panzer" division by DeGaulle and young American military experts, which the Nazis aped; and finally, culminating in the modern amphibious air-sea-land "blitz" armies which have reached their peak of development in the British 8th and the American 5th and 7th armies.

The modern "blitz" attack as first applied by the Nazis required swiftly massed and mobile striking power at several points; made rapid "feeler" feint attacks to keep the defense scattered, bewildered and offbalance; punched through a few mechanized thrusts at weak spots; sent tank "cavalry" units past the outmaneuvered defense on rampaging charges, disrupting communications and supply lines and disorganizing secondary reserves; sent short-range planes overhead to help hammer and demoralize the hacked-up defense lines; sent long-range bombers far to the rear to wreck supply depots and reserve concentrations; sent one or two overwhelming mechanized thunderbolts at the weakest points in the enemy lines; and finally, "outflanked, enveloped and destroyed" the bewildered and demoralized enemy. Thus the modern "T-Formation" and the "panzer blitz" become strange bedfellows.

It is patently obvious that to carry out such an intricately deceptive, highly mobile, multiple-prong attack, precise timing and perfect coordination between the various highly-trained "specialist" military arms are absolutely essential. The same holds true for the modern defense.

It is quite obvious that such a feat would be utterly impossible without the widespread use of elaborate signalling and com-

(Continued on page 302)



FM — *Today and Tomorrow*

A reduction of nearly 200 in the total number of AM broadcast stations, giving more elbow-room for those which remain in operation; an increase in the number of FM stations from the present 50-odd to 500, and a ten-fold increase in television stations is foreseen by Mr. David, who predicts that FM as well as television will be handled by great automatic networks.

By **W. R. DAVID** *

THE chart *(see map, above)* shows the condition of FM today. The solid circles represent present FM stations, the open rings FM construction permits, and the crosses applications pending. The phenomenal growth of FM broadcasting is a matter of record. One experimental station in 1938, Major Armstrong at Alpine, New Jersey; 7 in 1939; 11 in 1940; and in 1941 when the Government authorized commercial FM broadcasting, 18 commercial, 2 noncommercial or educational, and 14 experimental. During 1942 and 1943 the total jumped to 53, which is the number in operation today. The total number of stations today is: 900 AM (in round figures), the 53 FM transmitters and, to complete the picture, 9 television stations and 36 international short-wave stations either under construction or actually operating.

The existing stations are in large population centers. It is interesting to note that the service areas of these stations encompass from one-third to one-half of the total population of the United States. This represents an immediate postwar FM receiver market of large proportions. Considering the population served as 50,000,000 and assuming that one out of four will buy an FM receiver, the potential market is approximately 12,500,000 plus second receivers and car receivers. The approximately 600,000 FM receivers in use today hardly affects this calculation.

The skeptic can say that all of those listeners have AM receivers. However, a survey has shown that approximately 14,000 AM receivers fail each day and go permanently out of service. Further, it was estimated that 6,000,000 of the 60,000,000 AM receivers were out of service by June of this year. A strong incentive to purchase FM receivers will be the probable trend in postwar thinking that a receiver will be obsolete when sold if FM is not included.

Of course, the introduction of anything so new and different as FM creates problems, but none seem unsurmountable. The remaining problems are:

1. Continued explanation of FM to the public. This is being done by the leading radio manufacturing companies through institutional advertising.

2. Network support of FM rather than interest from the viewpoint of insurance or protection. This support is confidently expected.

3. Establishment of high-fidelity wireline and radio relay facilities. The present war developments will greatly facilitate the latter.

4. Big name programs. That will come with wholehearted network support.

5. More FM stations—The new station applications being filed, now numbering 56, are evidence of the impending postwar interest.

With the impetus that FM has today, continued rapid growth is assured. Tomorrow's wireless FM network will differ from today's in that separate relay transmitters will be operated on very high frequencies. They will be small units with highly directional antennas located at strategic high points and probably operated automatically. It seems reasonable that FM will eventually supplant all local, most of the regional, and some high power AM stations. Such a transition would be generally beneficial. It would give the public FM and better AM reception. The present AM band would be cleaned up, making more clear channels available for more high power AM stations. Possibly in the future we can have superpower, 500 kilowatt AM stations for long range coverage.

Here I stick my neck out and make a prediction:

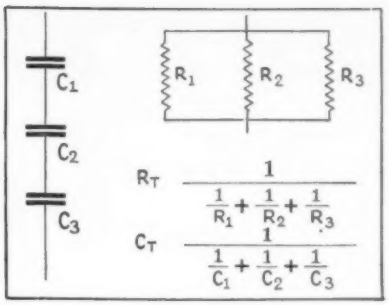
Five years after the war we will have 750 AM stations and 500 FM stations. Again — to complete the picture — 100 television stations and 50 international short-wave stations. True, this is only one prediction—but it is based upon our analysis of the trends and with some thought about the economics. If any of *you* care to make a prediction, I am interested.

*General Electric Co. Part of a speech delivered November 3, 1943.

Radio Men Need

THE SLIDE RULE

By WILLIAM B. MILLER



THE total resistance of two resistors connected in parallel, or of two condensers connected in series may readily be calculated by the method given in the first half of this article, (published in the December *Radio-Craft).* If there are more than two condensers or resistors, as in Fig. 1, the total resistance or capacity may be calculated more readily by the use of reciprocals:

$$R_t = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

(C may be substituted for R in the above formula.)

Calculations of this kind are very common in radio, and are among those which are exceptionally well adapted to solving with the help of the slide rule.

THE USE OF RECIPROCALS

Both of the last two problems could have been solved by reciprocals where:

$$C_t = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}} \text{ etc.}$$

R may be substituted for C in this formula.

So we will show how reciprocals may be handled with a slide rule.

Reciprocals may be solved in two ways. They may be considered as divisions with 1 as the numerator and the division carried out in a regular manner. The other method is to use the slide in an inverted position. We will illustrate the first method by a few examples:

Conductance (G) equals the reciprocal of resistance. R equals 500 ohms, G equals 1/500. Set the 5 on C to the left index on D, then under the right index of C will be found 2. We know from experience that it is .002 ohms. The rule for this is: To the D index set the number on C, then under the C index read the reciprocal of that number.

This procedure may be reversed and any decimal may be converted to a common fraction. Convert .25 to a common fraction: Set 25 on C to the left index on D, then under the right index on C will be found 4, giving us ¼ as the answer. The rule is: To the left index of D set the number. Below the right index of C will be found the denominator.

Suppose we have a fraction that has a numerator larger than 1, such as 4/5. This means 4 is to be divided by 5 and we do it as in ordinary division. There is an interesting result in this type of problem. For example, change .75 to a common fraction. To the right index on D set 75 on C, then under 3 on C will be found 4, also under 6 will be found 8 making ¾ and 6/8 as the answers. If .5 had been used instead the following answers could have been read 1/2, 1.5/3, 2/4, 2.5/5, 3/6, 4/8, etc., all with the same setting.

The second method of doing reciprocals is by means of the inverted slide. This means that the slide is withdrawn from the stock and replaced with the right index where the left was before, putting the C scale upside down next to the A scale. In this position, after all indexes are aligned, any two numbers on C and D are reciprocals, that is their product equals 1, (or 100, 1,000, etc.). To read these the hair line on the indicator is used to line them up with each other. Over the 2 on D will be found the 5 on the inverted C scale, over 6 will be found .166, etc. See Fig. 2. We can use the inverted slide for solving problems involving parallel resistors and series condensers. For example, find the effective resistance of three 5 ohm resistors, (1.666 ohms).

We invert the slide and read on the upside down C scale the reciprocal of 5. This is .2. As the formula reads, the resistance is equal to the reciprocal of the sum of the reciprocals of the separate resistors, so we add .2 three times to get .6. Then the reciprocal of .6 (from the slide) equals 1.666 ohms. If the resistors had been 50 or 500 ohms the answers would have been 16.66 and 166.6 ohms, respectively.

SQUARE AND CUBE ROOTS

Both the square and cube roots of any number may be found with the aid of the slide rule. Square roots may be read directly on the rule with no settings of the slide. The squares of numbers on scale D are directly above them on scale A, and may be read accurately by means of the hair line. The roots of the numbers on A are, of course, directly below on D. There are a few things to remember though.

If the left index of A is considered as 1, the middle is 10 and the right is 100. If the left index is considered as 100, the middle is 1,000 and the right is 10,000. Also, numbers 1. to 3.16 on D have squares 1. to 10 on A. Numbers 3.16 on D have squares 10. to 100 on A. Numbers 10 to 31.6 on D have squares 100 to 1,000 on the left half of A. Numbers 31.6 to 100 on D have squares 1,000 to 10,000 on right half of A and: If D runs .1 to 1 then A runs from .01 to .1 to 1. left the right. If D runs .01 to .1 then A runs from .0001 to .001 to .01.

The square root of any number on the A scale is directly below it on the D scale. But every number on the A scale is repeated. Thus we have two 9's, one just to the left of center, the other far to the right. The rule is:

If the number whose root is being extracted has an odd number of digits (to the left of the decimal point), the square root will be found below the number to the left of center on A. If it has an even number, the square root will be found to the right of center on A.

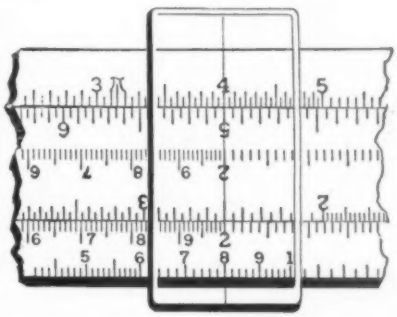


Fig. 1, top—By using reciprocals the total resistance or capacity here is easily found. Fig. 2, bottom—To find reciprocals on rules without a CI scale, simply invert the slider.

For example, let us find the square root of 36, which as everybody knows is 6. As 36 has an even number of digits, we look for 36 on the A scale to the *right* of center. Under it we find 6, as expected. If we wish to find the square root of 360, which has an odd number of digits, we look up 36 on the *left* of center, and under it find 19, as far as can be seen. (Actually 19 is the square root of 361.) If the number whose root we are seeking is 36.1, it remains an even number, and the root is slightly greater than 6.

The turns ratio of an output transformer is equal to the square root of the larger impedance divided by the smaller impedance. Let Z1 be 9500 ohms and Z2 be 500 ohms. Dividing 9500 by 500 gives 19. Find 19 on scale A (the ninth main division to the right of the middle 1), the hair line will then indicate on D the square root, 4.36. This is the required turns ratio.

Compute the current that will flow through a speaker whose voice coil impedance is 8 ohms and which is rated at 25 watts when fully loaded.

$$I \text{ equals the square root of } \frac{P}{R}$$

This problem may be solved in the usual manner, or in one setting by using the A and B scales for the division and then reading the square root directly on D.

Set the left 8 on B to the left 25 mark of A, then set the indicator to the middle 1 (index) on B, the hairline will pass through 1.768 (amperes) on D, which is our answer.

CUBES AND CUBE ROOTS

All four scales are used in computing cubes and cube roots. Set the left index of C to the number on D, then set the indicator to the same number on B and

(Continued on page 320)

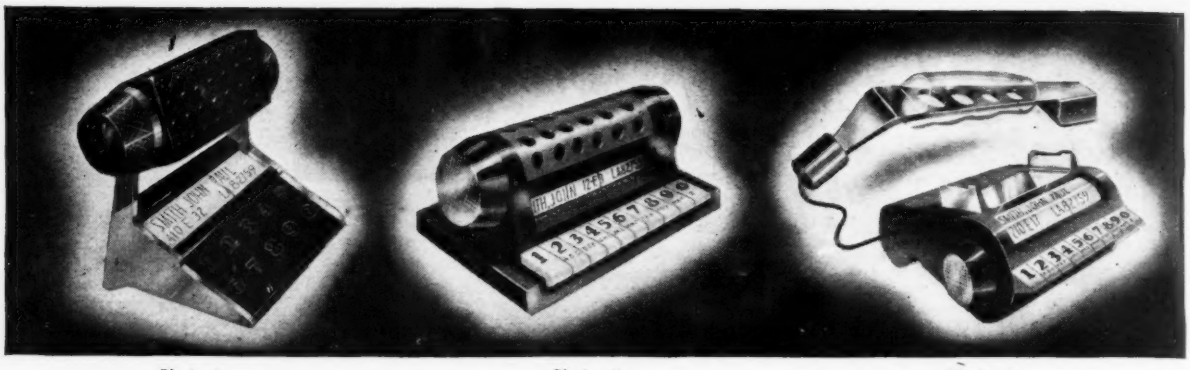


Photo 1 Photo 2 Photo 3

TELEPHONE *of the* FUTURE

By ELECTRA FIPS

"GOOD MORNING . . . This is the voice of the receptionist of today speaking into the telephone of tomorrow. What is this telephone of the future? It is the prediction of Donald Deskey, industrial engineer. When will it be in use? Only time can tell. Are you interested in this post-war telephone? If so, tune your future Great Crystal Gazers Model this evening to Lord Future. Deskey's telephone marks a great forward march in the post-war world. It will revolutionize the telephone and will make telephoning even more convenient than it is today. Is this possible? Anything can be possible. Science never stands still. In the days of crystal sets, it did not seem possible that short-wave reception, television, etc., would exist. Now we take these developments for granted. Never would the thought come to us that at one time these were merely predictions."

". . . Good evening all. This is Lord Future speaking. Have you heard about Deskey's telephone? His new telephone is revolutionizing the entire business and social world of the year 1964. It is being acclaimed by all our great business houses. Thousands of orders for installation have been received. In order to appease all the enthusiasts who have phoned us during the past few days for information, I will briefly explain the features of this telephone to you. Before I start I want you to notice the photos of this new telephone which will now be flashed on your television screen. These photos will stay on the screen till the description is ended, to make it more understandable.

"You recall the inconvenience we all have had with telephone directories, tumbling at our feet and making telephone tables untidy sights. How many times have we wasted valuable time trying to find a number in a public phone booth directory, only to find that some inconsiderate person has torn out the page. Also, many have experienced difficulty in reading numbers in poorly lighted booths and then in despair have to ask some kind person in the vicinity to read it for them. No longer will we have to go through all these trials and tribulations. *The telephone directory is going to be eliminated entirely.* It will be reproduced on microfilm and the names will be mounted on a device which allows the user to run through the directory at variable speeds, finally arriving at the number by a manual control. The names are projected through a magnifying lens and appear in an illuminated frame in the base of the telephone. See Photo 1. When the name and number are brought into position in the viewer the control mechanism is released and the number can be set up on push buttons. It is possible to incorporate this principle in the base of the present telephone, listing names possibly equivalent to the number in the New York telephone directory.

"No longer will we have the present dial system which wastes time because we have to wait for the dial to return before dialing the next digit and have to repeat this process six or seven times. A tab system is substituted for the present dial. The user simultaneously pushes down tabs with identifying letters or number symbols instead of dialing. See Photo 2.

"Another feature which certainly will be most welcome with all telephone users—the total elimination of wire. The hand instrument is absolutely wireless, thereby eliminating wire tangle nerves. The telephone can be carried to any point in the room. See Photo 3. How is this possible? We cannot divulge this secret at present. There's a war on, you know.

"The transmitter-receiver will be replaced by a microphone loud-speaker device. However, an earphone will be provided in the event that the user desires privacy for the incoming calls.

"How often have we all wished for an invention which would record all calls made while no one was available to receive the call. Here it is! A trip signal device for indicating messages received during the absence of the user is incorporated in a remote terminal cabinet.

"This telephone can also function as an inter-office or inter-home communicating system. Another advantage is that the user can select bell, chime or light signalling—whichever is most convenient.

"I am now signing off. You will hear from me again when this telephone will be publicly used. For the present let's all give our utmost to end this war and bring the predictions of 1944 into the reality of 1964."

●

Wartime Service Streamlined

SERVICEMEN in northern New York are switching to methods adapted to present conditions. A survey shows that hours, delivery methods and working arrangements are being adjusted to meet the conditions of labor and transportation scarcity, and of six- and seven-day weeks on odd shifts worked by many of their customers.

One serviceman opens at 6 a. m. daily, closing at 5 p. m. Another service center stays open till 9 p. m. Monday and Friday nights, but remains closed all day Saturday. Still another repair shop works from 10 or 11 in the morning to late evening.

These staggered hours get the various "shifters" as well as those workers on standard time who find that their hours coincide with those of the average radio man. In the past, it was an easy matter to take a half-day off now and then, in which little odd jobs could be done. Now that this is well-nigh impossible, the shop that is open before or after the regular stores or other places of business is appreciated.

Delivery comes in for a definite change in policy, too. One serviceman uses what he calls the "postcard system." When he accepts a set for service he requests the customer not to phone or stop in to see if it is ready. As soon as repairs are completed, he notifies the customer by postcard.

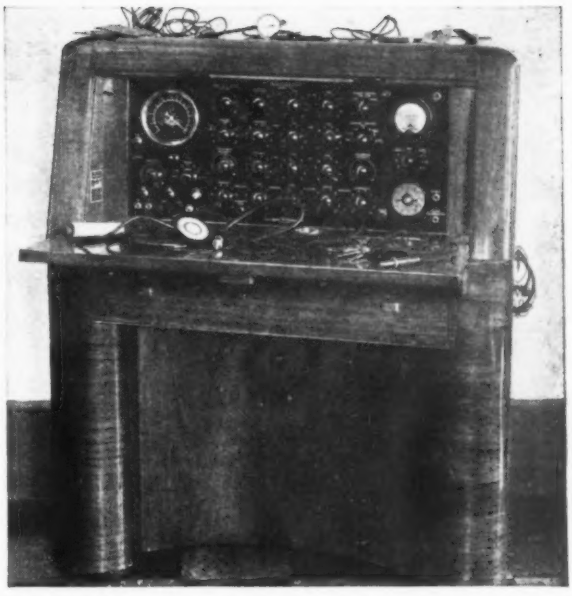
This serviceman reports a 20% increase in efficiency, because he doesn't have to spend time answering phone calls or personal inquiries from curious customers. He takes half-an-hour or less nightly and sends out a flock of cards which reach their destination in a day or two.

In one service shop a card was observed: "Don't ask us to pick up or deliver—Service is our problem—Transportation must be yours!" Several centers pool their deliveries and arrange with the local trucking concern to call at customers' homes for deliveries or pickups. The customer is charged with the trucking costs in addition to the regular bills. The truckman collects the total bill—his own and the Serviceman's.

Over 75% of the servicemen contacted have turned thumbs down on any and all credit for the duration. Parts are too hard to get and business is too pressing to bother with bookkeeping headaches. Besides, most of the girls who formerly handled the repairman's figures have been pressed into duty on the bench as additional repairmen, have jobs in defense plants, or are in the WACS or the WAVES.

"Radioclast"

the Latest Radio Swindle



The "Radioclast 40" is the latest of a series of pseudo-therapeutic devices. The excellent appearance and complicated-looking panel is designed to set at rest the doubts of persons who might not be taken in by a less impressive set-up.

FROM the earliest days, radio has had its group of dubious camp-followers. Who among us has not—in his beginner's period—purchased a guaranteed "static eliminator" to hook in series with his aerial? And which of us has not been chagrined to find, when tearing it apart to discover why it failed to perform, that at best it was a disguised .001 condenser and at worst a 201-A base filled with pure concrete?

The wonder associated with radio renders people ready to believe remarkable things of any device stated to work on electronic principles. Full advantage is taken of this fact by unscrupulous persons, who foist instruments of doubtful value on the public. One of the happy hunting-grounds of such racketeers is the field of therapy. The partly understood nature of many of the ills of the human body, coupled with the successful and legitimate use of radio frequencies in diathermic treatment, causes many simple souls to accept as reasonable the idea that some electronic machine might be invented which could cure a multiplicity, or all, of the ailments from which mankind suffers.

The latest outfit to cash in on this human tendency is the Electronic Instrument Co., of Tiffin, Ohio, and the "Electronic Instrument" purveyed by them is certainly the latest and by far the most elaborate of the machines which have been built to absorb the dollars of those who hope to enjoy the benefits of health by utilization of mysterious "radionic" emanations or vibrations.

The new device goes under the name of "Radioclast." (The name will have a familiar ring in the ears of those who remember the notorious Abrams "Oscilloclast" which was exposed in Hugo Gernsback's RADIO NEWS in 1924.) Unlike earlier radio-health "instruments," which looked like converted spark-coil medical cabinets, or at best like out-of-date 5-tube radios, the Radioclast is a classy-looking console 44 inches high, and is decorated with no less than 24 main tuning controls, plus a few knobs, switches, buttons and just gadgets.

It sells for a mere $1,000 ($945 has been quoted as a "bargain" price). It is supposed to detect, diagnose and cure everything from double vision to a bone in the colon. (Actual extracts from "The Radioclast News" issued by backers of the device.)

It is claimed to be (and actually is) capable of producing long, short and intermediate radio frequencies. Therefore, according to "radioclastic" theory, it should be capable of diagnosing and curing all diseases! How likely such claims are we shall see.

A TYPICAL "DIAGNOSIS"

The instrument, as can be seen from the photograph, has a hinged front lid which opens up, something in the manner of a desk. On the table thus formed is a black glass plate, mounted flush with the board. Under this is a screen, which is connected to the circuits of the machine as shown in the diagram (upper right corner).

The patient holds an electrode in his hand, his fingers touching the center, which provides another contact. The electrode is plugged into the "In" jack, and the "doctor," dipping his hands in talcum powder, begins a rhythmic stroking of the little black plate with one hand, turning dials

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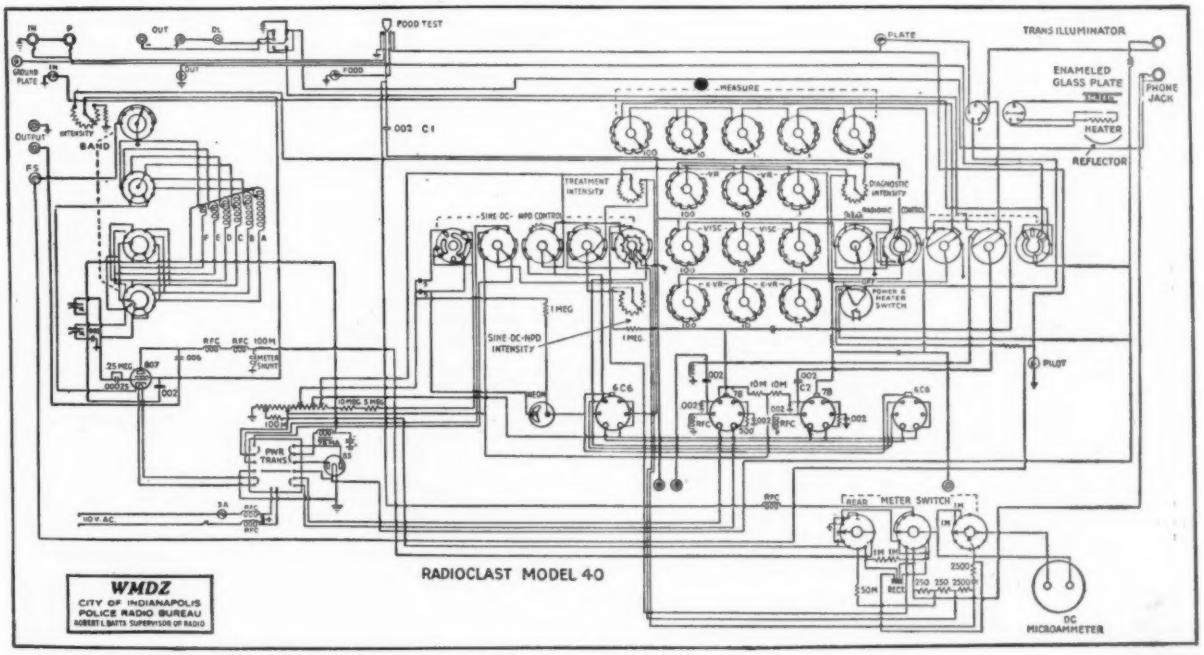

RADIOCLAST MODEL 40

An Electron Counter

An ingenious method of getting around the problem of evacuating the counting chamber makes this a practical instrument for many experimenters who have some laboratory facilities but are not equipped to construct the conventional Counter

By B. H. PORTER

RECENT letters to the editor of *Radio-Craft* suggest a widespread interest in the automatic detecting and counting of alpha* radiation from radioactive substances. Of the many types of recorders designed for this purpose the point-electrode type of Geiger-Mueller counter is the easiest to construct. When used in conjunction with thyratron-control tubes like the G.E. FG-17 this device will indicate both visually and audibly the fast moving particles from radium, uranium and similar bodies.

THE COUNTING CHAMBER

It is the counting chamber that performs the first function in this system. Brass tubing of the approximate dimensions shown in Figure 1, or solid stock lathe-turned to these proportions, is closed at one end. A hole, reamed on the inside, is centered on this end for entrance of the particles. A bakelite stopper is fashioned to fit the other end of the chamber tightly. Through this passes the ⅛-inch rod of brass having a Fahnstock connector clip at one end and the tungsten point at the other. In operation this rod is adjusted in the stopper so that the point is roughly 3/16 of a inch from the inside face. The entire chamber is now mounted on a bakelite rod with a suitable base as shown. A second Fahnstock clip is placed just under the chamber to provide electrical connection.

*There are three types of radiation from radium: alpha, beta, gamma. A magnetic field will bend the first type toward the right, the beta to the left and allow the gamma radiation to pass directly through unmolested.

Pieces of tungsten wire (0.78 mm. diameter) are ground on a lathe to a fairly true point with a No. 4 India stone and to about 3.0 mm. back from one end. A hard Arkansas oil stone is then used until, with a 20x Hastings Tripplett glass, the point appears very fine and sharp. Polishing with a pinch of tin oxide (Diamontine) on the top of a hard wood surface follows. With alternate periods of rest and operation such a point electrode will function satisfactorily

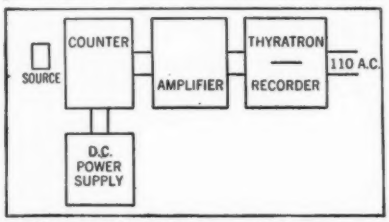

Fig. 2—A block diagram of the set-up.

from two to three weeks and, upon being found useless, can be reground. Approximately 1800 volts (D.C.) may be impressed upon similar points before sparking over to the chamber occurs. Such sparking is normally injurious, however. Cleansing in alcohol and heating to blueness in a bunsen flame coupled with a rest period eliminates operation failure and tends to decrease the voltage necessary for reliable and satisfactory operation.

THE ELECTRICAL CIRCUIT

The electrical circuit that feeds these parts consists of four units: the D.C. power supply, counter, amplifier, and thyratron circuits. (Figure 2.)

The power supply is the standard type which rectifies the 110-volt A.C. imput to a variable D.C. output. In this case a range of 500 to 2500 volts output is ample. The unit may be purchased commercially or be constructed according to standard specifications.

This supply feeds directly into the chamber unit shown in Figure 3. The ionic charge collected by the fine tungsten point after the entry of a particle from the radioactive source under study, produces in the chamber a potential variation that affects the grid potential of the 6J5 detector-amplifier tube. Battery supplies for the tube, two resistors and a condenser complete the circuit.

It will be noted from the diagram that the positive side of the high voltage source and the shielding about the unit are both grounded. This shielding is necessary to cut out high-frequency disturbances from nearby induction coils or similar disturbing equipment that may exist. Copper screen may be used to encase this part of the circuit and counter.

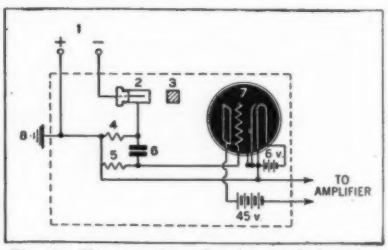

Fig. 3—The counting chamber and detector.

The voltage impulse from the grid of the first tube is amplified in the second unit or circuit. (Figure 4.) This is a standard two-stage amplifier similar to those discussed elsewhere in back issues of this publication and like those available commercially. Two 6J5 tubes with the necessary controls, batteries and transformer comprise the full circuit as shown. It will be noted that headphones or a loud-speaker may be connected into the circuit at this stage for the purpose of hearing each particle from the radioactive source "spilling over" as it were the high potential between the tungsten point and the brass chamber.

If the anode current surge from the last tube of the amplifier is now applied as in Figure 5 across the grid of a G.E. FG-17 thyratron, the latter discharges, provided it has been adjusted critically above the background of hum from outside disturbances. The anode current of the thyratron itself is now limited to just sufficient strength to move the armature of an automatic recorder (see Central Scientific Co.,

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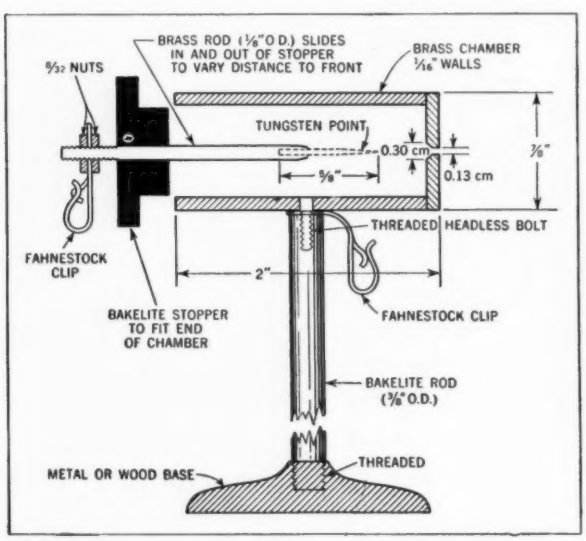
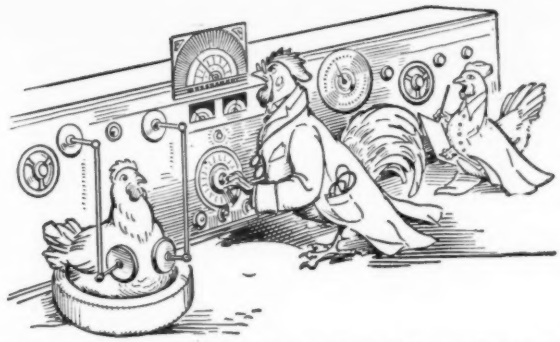
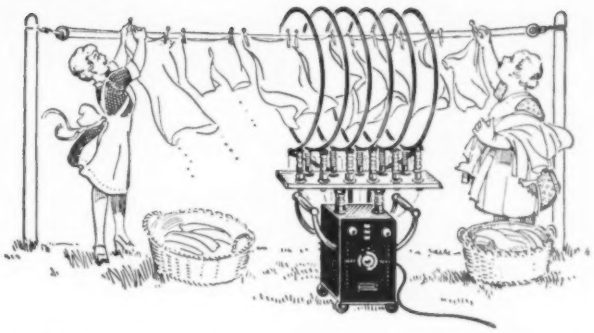


Fig. 1.—Detail of the chamber. The drawing is practically self-explanatory. Instead of making it vacuum-tight, the whole apparatus, together with the radio-active material, is placed under a bell-jar. A simple type of air-pump then will easily produce the low vacuum required for this type of instrument.



The electronic therapy of the future as it might be applied to the farm egg-producers.



Drying the wash may become a five-minute job if a Brooklyn inventor's dream is realized.

Inventors and Electronics

By S. R. WINTERS

TENNYSON'S poetic fancy gave a preview of fleets of aircraft zooming through the skies long before the Wright brothers actually lifted a flying machine off the sand dunes of Kitty Hawk, North Carolina. The late Nikola Tesla, electrical wizard, predicted so many electric marvels that scientific laboratories have been busy, through the years, translating his dreams into realities. Visionary scientists had already thought of riding to the moon by rocket before two government engineers recently invented a method of running lawn mowers by radio.

Cutting grass by the same radio waves that brings a Beethoven sonata, or that doleful tune, "At the End of the World," into your home, may sound fantastic even to the credulous. However, two well-known radio engineers—Charles L. Paulus and Raymond K. Stout—of Dayton, Ohio, have not only patented the idea, but outlined how a lawn-mower may be started, steered and stopped by wireless waves. The same automatic mechanism may be employed in operating manless automobiles, trucks, jeeps and other military vehicles, as well as such implements as plows, rakes and harvesters.

The stress of war-time conditions must have spurred these inventors to develop this labor-saving system. Then, too, the tempo of civilian life has been changed by such necessary circumstances as blackouts. This automatic steering and control mechanism is intended to operate passenger vehicles and military trucks during air-raid alarms, because manless mobile units, remotely controlled by radio, can travel along well-defined courses without the usual glare of lights.

ELECTRONIC GRASS-CUTTER?

Taking the lawn-mower as an example of how wireless waves can guide a mobile unit, a cable is located beneath the sod of lawn, either permanently or subject to quick placement or removal as changing courses may dictate. This cable is charged from a source of low-frequency current, not exceeding audible wave-lengths, and the circuit is completed by grounding the cable. It defines a path of travel for the mower in much the same manner as beams of radio waves chart courses for airplanes.

The lawn-mower is the receiving end of this invention—the guiding cable being a miniature broadcasting station. The mower or other mobile vehicle is equipped with coils of wire, or pick-up antennas, in tune with the waves emanating from the guiding cable. A reversible electric motor operates the steering wheel of the vehicle. The pick-up coils are connected to radio amplifiers, which enlarge the volume of the signals as they start, steer or stop the mower moving over the lawn or automobile traveling a well-worn highway. There are automatically-tripped electric relays for controlling the steering wheel of the vehicle, and other relays keep the mobile device on its charted course.

The inventors suggest that their automatic steering and control mechanism is so flexible that the cable can function above the ground, and the system—in an enlarged form—can operate fleets of buses, relieving fatigued drivers from steering, and at the same time conform to the war-imposed 35-mile-an-hour speed limit. This transit service may be a revolutionary post-war application of radio.

DRY THE WASH BY RADIO

It may seem fantastic to think of abolishing the traditional Monday wash-day with the clothes hanging on a line to dry. But, according to another recent invention it is now within the realm of possibility to apply a radio-drying process to garments, as well as painted metal surfaces, lithographic ink, volatile solvents, and water-impregnated articles.

A radio-frequency induction coil is employed for heating and drying articles. The radio waves thus used may be of the same length or frequency as those which bring in your favorite songs and jokes. The metal surfaces or water-soaked fabrics to be dried are brought, by an automatic conveyor, within the field of these radio waves.

Sometime ago science introduced the radio furnace which melts metals by the heat of radio waves. Such apparatus is too cumbersome for doing small jobs around the house, shop, or small factory. This invention, of James J. Morey, Brooklyn, provides a small chamber, instead of a large furnace, which includes a conveyor for carrying the articles to be dried. There are two radio coils of wire—the two being in the path of the automatic conveyor for applying the heat in progressively higher degrees.

This radio heater is self-contained for drying a liquid coating or water-impregnated article. The units include a casing which contains the heating chamber and carrier arms fastened to links of a sprocket chain. The latter moves in a path above and parallel to the lower surface of the heating chamber. In addition, there are supports for the article to be dried, these supports taking the form of an inverted T, with hooked upper ends to engage with the hooked lower ends of the carrier arms. These mechanical supports carry a number of articles at one time. The sprocket chain is endless, thus forming an endless traveling conveyor.

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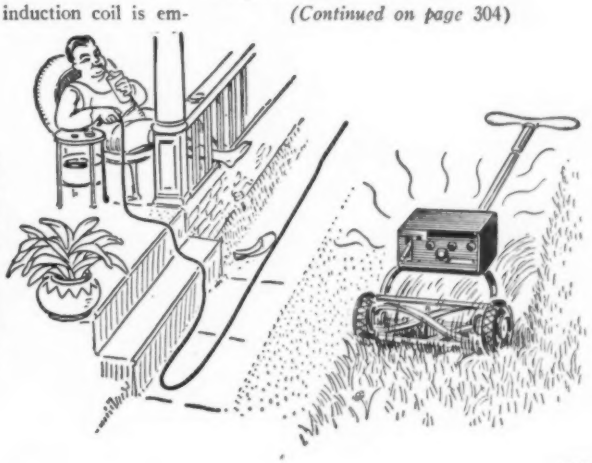

The radio lawn-mower gets its control signal from a cable stretched on a convenient walk or along an edge of the lawn. The operator can relax in a comfortable chair, out of the sun, and sip a cool drink while controlling the hard work of getting the grass clipped.

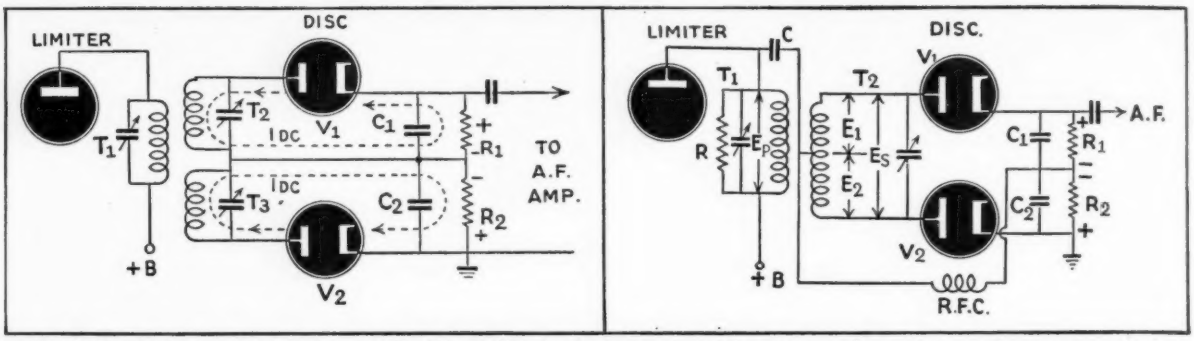

Fig. 1—The Travis discriminator, shown at the left, is difficult of adjustment and is not generally used in modern receivers. It is now chiefly used to illustrate the principle of the circuit. Fig. 2—The Foster-Seeley circuit, used in most FM receivers.

FM DISCRIMINATORS

By **JULES M. KLEINMAN**

A METHOD by which an ordinary A-M (usually a superregenerative) receiver may detect FM signals was described at the end of the preceding article. A more practical method of FM detection is shown in Fig. 1. This method (discrimination) is used in all standard FM receiving apparatus. The circuit of Fig. 1 is known as the Travis Discriminator.

The limiter output is coupled to the plates of two diode detectors by means of the tuned primary T1 and the double tuned secondary windings T2 and T3. The primary T1 of the I.F. transformer is tuned to the *mean* I.F.; tuned secondary T2 is tuned slightly higher than the expected deviation; and tuned secondary T3 is tuned slightly lower than the expected deviation in the opposite direction. Let us take for example a *mean* I.F. of 450 Kc., then T1 is tuned to 450 Kc., T2 to 470 Kc., and T3 to 430 Kc.; 5 Kc. more in both the plus and minus direction to insure that the total frequency swing is accommodated. Let us now assume that an unmodulated R.F. carrier is coming through the receiver.

Since the impedance of any parallel resonant circuit is maximum at resonance, the R.F. voltage across T1 will be maximum, and since T2 and T3 are tuned to the maximum deviation frequencies in opposition respectively, the induced voltage across T2 and T3 will be equal and opposite, and equal and opposite D.C. currents will flow (as shown by the arrows) through detector load resistors R1 and R2. Since the currents flowing through R1 and R2 are equal and opposite, the voltage drops across R1 and R2 will be equal and opposite and the net A.F. voltage will be zero.

Let us now suppose that the carrier is instantaneously deviated plus and minus 10 Kc. or to 460 Kc. and 440 Kc. respectively. As the frequency deviates from the mean 450 Kc. to 460 Kc. the impedance of T2 will *increase* and that of T3 will *decrease;* therefore, there will be a larger voltage drop across T2 and a smaller voltage drop across T3. The R.F. voltage impressed on the plate of V1 will *increase* and that on V2 will *decrease*. The D.C. plate current flow from V1 through R1 will be greater while that of V2 through R2 will be smaller; then the resultant voltage drop across R1 with respect to ground will be positive and greater than the voltage drop across R2 with respect to ground. The net audio voltage will be the algebraic sum of the two voltage drops plus R1 and minus R2 and will present itself as the positive half cycle of audio. This half cycle will be proportional in *amplitude* to the magnitude of deviation, and proportional in frequency to the *rate* of the deviation. As the mean frequency deviates to 440 Kc., the impedance of T3 *increases* and that of T2 *decreases* by the same amount, hence, the plate current of V2 increases and that of V1 decreases, the voltage drop across R2 increases and R1 decreases, and with respect to ground the net voltage will be *negative* by the same value as the positive half cycle. A complete cycle of audio has thus been converted from the two deviations of the mean frequency, employing full wave diode detection.

The Travis discriminator is not found in modern FM receivers because of the difficulty of adjustment of the tuned circuits, but serves to bring to light the general action of FM detection.

The discriminator which has the greatest practical use is simpler in construction and operation, though its workings are not quite as easy for the student to understand.

THE FOSTER SEELEY TYPE

This discriminator is the conventional type employed in practically all modern FM receivers. The schematic is shown in Fig. 2 (a). Here we have practically the same circuit as the Travis except for the elimination of the double tuned secondary. In this circuit the tuned primary T1 and the tuned secondary T2 are both resonated at the mean I.F., say 450 Kc. Not only do we have inductive coupling between T1 and T2, but also direct coupling through C to the center of T2 which divides the secondary winding into two separate windings electrically. The D.C. return of V1 and V2 is made through an R.F. choke R.F.C. to keep R.F. out of the load resistors R1 and R2. C1 and C2 are R.F. by-passes.

The best method of analyzing this circuit is vectorially. Let us again assume that the mean I.F. is coming through the detector. The following action occurs: The R.F. voltage and current flow through T1 will be in phase (we are only interested in the primary voltage Ep) the induced secondary voltage Es is 180° out of phase with Ep and the secondary current Is is in phase with Ep as T2 is also resonated at the mean I.F. These conditions are shown at 3 (a). We also have the primary voltage Ep fed directly to the center of T2 which splits the coil in half (keep in mind that the voltage at the center of T2 is in phase with Ep) then, actually, the secondary consists of two coils in phase opposition.

The induced voltage E1, we know, will lead the induced current Is by 90°, and the induced voltage E2 will lead Is by 90° in the opposite direction, and the resultant voltage applied to the plate of V1 will be the vector sum of E1 and Ep 90° out of phase, and that applied to V2 will be E2 and Ep 90° out of phase in the opposite direction, with E1 and E2 being 180° out of phase. The vectorial addition in 3 (a) indicates that the resultant voltages EV1 and EV2 will be equal in magnitude and opposite in direction; through the resultant current flow from V1 through R1 and from V2 through R2 being equal and opposite the net audio voltage will be zero. There exists a balanced condition as long as the mean I.F. is 450 Kc.

Now let us see what happens when the mean I.F. deviates to 460 Kc. Since T1 is

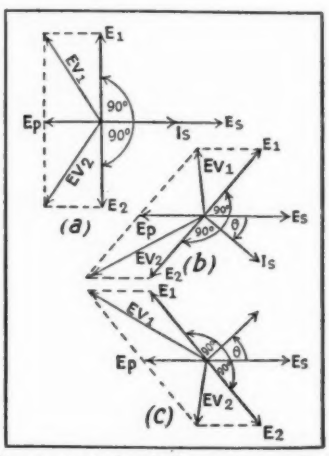

Fig. 3—A study of the vectors explains how signals are "detected" by the discriminator.

damped by R it maintains the same response over the deviation range, but T2 is sharply tuned to the I.F. and since the frequency has increased to 460 Kc. the inductive reactance of T2 will increase proportionally; therefore, Is and Es will no longer be in phase, but Es will lead Is by some angle e proportional to the increase in inductive reactance. This action is shown at 3 (b), but the induced voltage El and E2 will still lead Is by 90° across the coil of T2. We then have the vectorial addition of El and Ep at some angle *greater* than 90° and of E2 and Ep at some angle *less* than 90°. From the addition it can be seen that the resultant EV1 is less than EV2, but are still opposite. Then the rectified current flow from V2 through R2 is *greater* than the rectified current flow from V1 through R1 and the resultant voltage drop across R2 will be greater (negative with respect to ground) than that across R1 (positive with respect to ground); the net audio voltage will be negative (the algebraic sum of positive IR1 and negative IR2). The negative half cycle of audio is thus completed.

Next the mean I.F. deviates to 440 Kc. Since the frequency is now decreasing the capacitive reactance of T2 will increase and Is will lead Es by the angle θ as shown in 3 (c). Then El and Ep add at some angle *less* than 90° and E2 and Ep at some angle *greater* than 90° as in 3 (b); therefore, EV1 is greater than EV2 as in 3 (c) and the resultant rectified current flow through R1 will be greater than through R2, with the net voltage drop being positive with respect to ground. The positive half cycle is thus completed, and full wave rectification has occurred with the amplitude of the audio voltage across R1 and R2 proportional to the magnitude of deviation and the frequency of the audio signal proportional to the rate of deviation. This method is the most economical and the simplest to keep in balance. There are modifications of this system, but all coincide to the analysis given.

The audio system of the FM receiver is the same as of the A-M system and needs no further explanation.

SPECIAL CIRCUITS IN FM

Certain circuits are used in FM receivers to improve the performance. Among these circuits are the following:

A.V.C.: Sometimes employed in FM receivers which have but one limiter. This feature is used to shorten the range of signal strength over which the limiter has to function; however, the method of obtaining and applying the A.V.C. voltage to the R.F. and I.F. stages is the same as employed in A-M receivers.

SQUELCH: FM receivers are designed to have an optimum sensitivity over a wide frequency channel. This means that with no signal coming through the receiver a relatively large hiss is present in the audio output. The hiss becomes very annoying to the listener, and for this reason the squelch circuit was designed. The purpose is to deaden the receiver at all intervals when no signal is coming through. In Fig 4 is shown the schematic of a simple squelch circuit.

Analyzing, we find that a portion of the limiter grid current flows through potentiometer R and the resultant negative voltage is applied across the squelch filter diode, R2, and C to the grid of the squelch amplifier. When there is no signal coming through the receiver then the grid of the squelch amplifier is at zero potential and plate current flows through R3 producing a voltage drop across R3 which is negative at the top; this negative voltage is applied directly to the grid of the first audio amplifier and is proportioned to drive the audio grid to plate current cutoff, disabling the receiver.

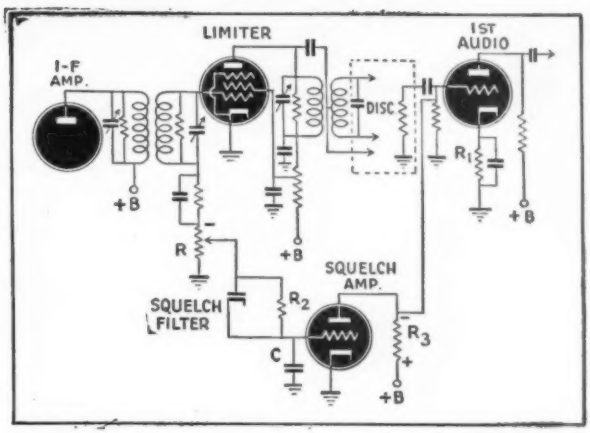

Fig. 4—A "squelch" circuit, similar to the "silent a.v.c." used on some broadcast receivers. The purpose of this circuit is to prevent noise from coming through when no carrier is present. As soon as a station is tuned in, receiver sensitivity is restored.

When a signal comes through the receiver a negative voltage is built up across R as limiter grid current flows. This voltage is applied across C to the grid of the squelch amplifier, driving this grid to plate current cutoff. Since there is no current flow through R3 no voltage drop exists. The audio amplifier acts as a normal cathode biased stage, and the signal is heard. This tripping of the squelch occurs instantaneously with the application of a signal. The purpose of the squelch filter, (R2 and C) is to act as a fast performing, slow release type filter to insure against tripping of the squelch from high level noise peaks that cause the limiter to draw grid current. Since C is usually a high value, before it has had sufficient time to charge to a high enough negative value to cut off the squelch tube, is shorted by the squelch filter very rapidly, and is automatically reset to charge on the next noise peak. The setting of R will determine the signal strength at which the squelch filter will be tripped.

A.F.C. OF TRANSMITTERS

In the installment on the Reactance Method of Modulation it was stated that the method employed to stabilize the oscillator in police type FM transmitters would be discussed. With the discriminator circuit shown in Fig. 5 it is quite practical to obtain frequency stabilization of a self excited type transmitter comparable to a crystal oscillator. V1 is the reactance modulator; acting as an *inductive reactance;* V2 is the electron-coupled transmitter oscillator whose resting frequency is determined by the constants of T; V3 is a combination triode-pentode converter tube; and V4 is a conventional discriminator.

A portion of the R.F. output of V2 is taken off by means of a pickup coil L and fed to the injection grid of the converter V3. The stabilizing oscillator section of V3 utilizes a triode crystal oscillator which is tuned the I.F. higher than the fundamental of T by the constants CX and T1. The crystal oscillator section is electronically coupled to the pentode mixer section and the discriminator transformer T2 is tuned to the I.F. The D.C. return of the grid of V1 is not made directly back to the cathode, but through R and the discriminator load resistors R1 and R2.

As long as the transmitter oscillator V2 is exactly on its resting frequency the voltage across R1 and R2 is zero, and the only bias on the reactance modulator is the cathode bias developed across R3, but if the resting frequency of V2 drifts to a higher value the discriminator circuit will unbalance and a negative voltage will be present across R1 and R2 in proportion to the increase in frequency. The bias on V1 is increased and the plate current flow from V1 will decrease, bringing the oscillator frequency back to its resting value. If the transmitter oscillator frequency drifts be-

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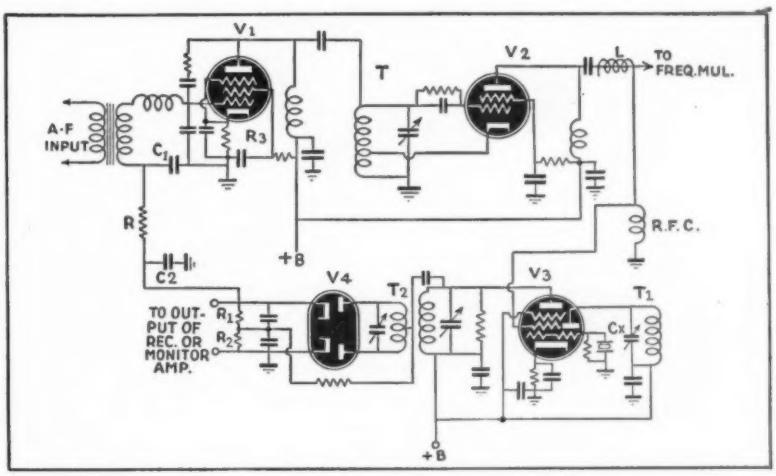
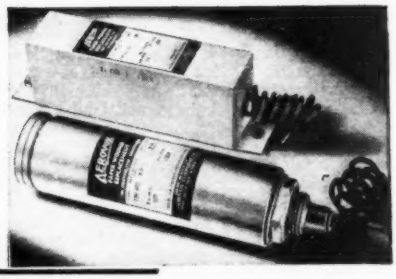


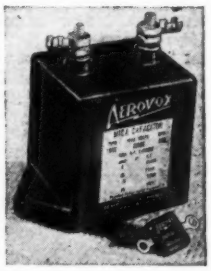
Fig. 5—The discriminator as frequency stabilizer in self-excited FM transmitters. A voltage is fed back to the reactance tube to oppose any frequency increase or decrease.

Using Capacitors



By CHARLES GOLENPAUL*

With the development of many new types of electronic equipment, capacitors are becoming even more important than they have been in the past. Their application to time-delay control circuits demand condensers of far greater capacity than has been common in the past. The increasing use of ultra-high frequencies, on the other hand, increases the importance of very small temperature-controlled capacitors.



COMPARED with other circuit components, capacitors are simple. In neither construction nor theory are they complicated. The very symbol for the capacitor is significant in its plainness. Unfortunately, its simplicity has led some technicians to minimize the function of the capacitor and to neglect the rules concerning its applications.

The highly important tasks delegated to capacitors in radio and electronic circuits dictate that these components be "engineered" into the circuits according to established rules of good practice. Other factors than capacitance and voltage rating must be considered in capacitor selection, although these two are basic. These other factors include *power factor, ambient operating temperature, mounting space, capacitor type, temperature compensation, Q, R.F. or A.F. impedance.*

It is the purpose of this article to review the principal applications of capacitors and to list the rules governing their use in electronic circuits.

PRIMARY CONSIDERATIONS

Capacitance and *operating voltage* are the first factors to consider when selecting capacitors, with capacitance perhaps taking the lead. Capacitance must be adequate for a given circuit function, such as by-passing, coupling, or power supply filtration, and occasionally must be of a critical value, as in tuned-circuit and wave-filter applications. Capacitor rated operating voltage must be sufficiently *in excess* of actual voltages to be encountered in the circuit as to provide a good safety factor. These two capacitor selection factors will be considered separately later on in this section.

Remaining primary considerations are *type* and *style*. These factors are governed by circuit requirements and mechanical features. For example: capacitor function in the circuit, together with capacitance requirements, will determine type, whether paper, wax, oil, mica, or electrolytic. Chassis or case space requirements together with various circuit demands such as insulation and shielding will dictate style; whether capacitors will be cylindrical or rectangular in shape, large or small in size, metal-enclosed or of unshielded construction, whether provided with terminal screws, pig-tail leads, or soldering lugs, or enclosed in conducting or non-conducting case material. The probable presence of heat near the point of mounting must also be taken into consideration when choosing type and style.

*Aerovox Corporation, New Bedford, Mass.

VOLTAGE RATINGS

Capacitor operating voltage is an important factor related to capacitor life. In order to secure maximum dependability, attention must be given this factor when selecting capacitors for any electrical circuit. Capacitors operated at voltages higher than safe working values are in danger of immediate failure.

Safe working voltage values are recommended by the capacitor manufacturer and are indicated on the capacitor labels. Occasionally, both working and surge peak values are stated.

When selecting capacitors, the same rules governing choice of any electrical components across which voltages are impressed must be observed; namely, *a generous safety factor must be provided.* If, for example, capacitors are to be subjected to 200 volts D.C., it is not good practice to operate "on the nose" with units rated 200 volts working. Rather, a 400-volt unit is chosen. This permits an abundant margin of safety.

When capacitors are to be employed in A.C. circuits, it must be borne in mind that they will be subjected momentarily to considerably higher voltages than the value indicated by a good A.C. voltmeter. Once during each half-cycle, these capacitors will be called upon to withstand the *peak* value of the alternating voltage, and this will be very nearly one and a half times the R.M.S. value shown by an A.C. voltmeter. Capacitors employed in A.C. circuits accordingly must be rated to withstand the peak voltage value. A.C. voltages must be lower than 70% of D.C. rating.

MIXED VOLTAGES

In some circuits, such as audio- and radio-frequency amplifiers and oscillators, control systems, power supplies, etc., alternating and direct voltages are frequently present in combination. The A.C. is considered to be super-imposed upon the D.C. Fluctuating plate and grid voltages in amplifiers and oscillators and ripple voltages in power supplies are examples. When selecting capacitors for such circuits, due cognizance must be taken of the combined voltage and of the peak value of the A.C. component.

A thorough investigation, theoretical or practical or both, should be made of any circuit in which A.C. and D.C. components are known to be present, since very often in these circuits the A.C. component is unsuspectedly high enough in value to exceed the rating of a capacitor chosen with the D.C. voltage alone in mind. Whenever obtainable, a peak-reading A.C. voltmeter, preferably of the electronic type, should be used to measure the A.C. component.

The circuit designer or experimenter therefore must not be content, when deciding upon desired capacitor voltage ratings, to determine only the D.C. values in the circuit but must ask as well "are A.C. components present, and how high are their peak values?" His final selection of working voltage must be based upon these values.

CAPACITANCE TOLERANCES

A few electronic applications require closely maintained capacitance values. These include tuned circuits, wave filters and timing devices. In other more common applications, such as coupling, power supply filtration, and blocking, wide tolerances are permissible; although definite capacitances may be called for by circuit design.

In critical circuit positions, deviation from required capacitance values must be very small. In blocking or filter applications, tolerances of plus or minus 40% and higher are permissible, and little is gained by use of scarce, low-tolerance units.

In power supply filters, where capacitances between 8 and 40 mfd. are common, exceptionally high tolerances are permissible without serious impairment of operation. In making capacitor replacements in such circuits, however, the capacitance of the replacement should be of the same order of magnitude as that of the replaced unit. Thus, a 40-mfd. capacitor would not generally be installed to replace an 8-mfd. unit. However, the wide tolerance of the 8-mfd. replacement might make 12 mfd. replacement a reasonable value.

Where critical capacitance values are demanded by equipment to be operated at specific frequencies, and considerable accuracy is required, the user should arrange to have the capacitor manufacturer measure capacitance of the special units at the

(Continued on page 303)

RADIO METERS

By ALFRED A. GHIRARDI

PART IV

Errors Externally Caused; Checking Instrument Accuracy

IF effective precautions were not taken during the design of an electrical indicating instrument to prevent it, change of *external* temperature would cause appreciable change in the indication of the instrument, due to the changes produced thereby in its various parts. The external-temperature influence is defined as that percentage change in the indication of an instrument which is caused by a difference in *ambient* (surrounding) temperature from the *reference* temperature (usually 25°C).

Changes of *external* temperature produce widely differing effects on instrument parts. For example, increased temperature causes linear expansion of metal parts, increased resistance of most current-conducting parts, change in elastic force of the springs, change in the operating characteristics of instrument rectifiers, etc. The design of modern high-grade instruments has been so perfected, however, that instrument errors caused by these changes are minimized—often by so proportioning the various design factors that one error is deliberately balanced against another of directly opposite sense, thus cancelling the effect of the original error.

Test instruments are calibrated at a 25-degree Centigrade (77°F) reference temperature, and are so designed that errors caused by ordinary room temperature variations in temperate climates are negligible and will not exceed the manufacturer's guaranteed accuracy. Abnormal heat or cold, of course, does cause increased error and must be mitigated if accuracy is essential, but since most of his measurements are made indoors, the radio-electronic service man rarely has to make measurements under such conditions of temperature. Perhaps the most severe temperature change his instruments encounter is when they are taken into a warm room for use after they have been in the outside cold for some time during transportation to or from a service job during winter weather. In such instances, the instruments naturally and gradually return to normal operating temperature in the warmer room. Sufficient time should be allowed for this to occur before taking exact readings.

The use of A.C. rectifier-type instruments at extremely low or high temperatures is not considered good practice. Because of the temperature characteristics of the rectifier the accuracy of these instruments varies widely from point to point on the scale at extreme temperatures. Also, continued exposure of these instruments to temperatures above about 55 degrees Centigrade (131°F) usually causes permanent-damage to the rectifier, and consequent change in indication. Keep them a safe distance from hot steam radiators in the winter time!

FREQUENCY AND WAVE EFFECTS

Inaccuracies introduced when indicating instruments are used to measure current or voltage values whose frequency differs from the rated frequency of the instrument by more than 10%; or by making measurements on circuits having wave form or shape other than sine-wave are next to be considered. These, of course, occur only in measurements of *alternating* current or voltage.

The capacitors used in the circuits of certain A.C. voltage-measuring instruments make the circuits most accurate at the one particular frequency at which such instruments are calibrated, and progressively in error as the frequency increases or decreases from this value. This variable error also exists in certain capacity-measuring circuits which are dependent on frequency for their operation.

Output indicators, when used with a series capacitor, also are subject to large reading errors due to the wide change in capacitive reactance of the capacitor over the audio-frequency band. For example, at 50 cycles, a 0.5-mfd. capacitor has a capacitive reactance of 6,369 ohms and at 10,000 cycles, only 32 ohms. This would change the reading more than 6% in a circuit having 100,000 ohms total resistance, and more than 10% in a circuit having 50,000 ohms total resistance.

This is not a serious effect, for in tuned circuit alignment work where output indicators are usually used, most service men employ a modulated R.F. oscillator having a fixed audio modulating frequency (usually 400 cycles); the modulating frequency therefore, does not change during the alignment procedure. Too, since it usually is not necessary to know the actual value of the output voltage, accurate voltage readings are not absolutely necessary in this work; only an indication to show when *maximum* voltage output is obtained is usually required. However, this requirement may change when the servicing of the complicated types of receivers found in television work becomes more widespread. In this work, the output meter can serve the important function of determining that the servicing performed has returned the set to its original standard of performance when it rolled off the production line. In such work, it is necessary to use an output indicator, the error of which is known.

The error that results when an A.C. instrument that has been calibrated on the basis of a sine-wave current is used to measure a current whose wave form or shape departs materially from that of a sine wave is important in some work—especially in connection with measurements made on television equipment, small generators, etc. Whenever rectifier-type A.C. instruments are used at any frequency, due regard must be paid to the nature of the wave shape being measured. Rectifier instruments actually give deflection proportional to the *average value* of the wave shape being measured, but for convenience, the scales are nearly always marked to indicate the *R.M.S. values* instead, the instrument being calibrated on a *sine wave*. (For sine waves the *R.M.S.* value is 0.707 of the *peak* value.) Since the numerical relation between the *R.M.S.* value (or the average value) and the *peak* value is different for other wave shapes, such instruments do not indicate accurately when used to measure them. When wave shapes other than sine-wave are encountered, it is often preferable to use either the magnetic-vane or the dynamometer type of instrument.

ERRORS CAUSED BY INSTRUMENTS

Since the function of an ordinary indicating instrument is to measure the current, voltage or resistance of a circuit, it should not alter or influence the

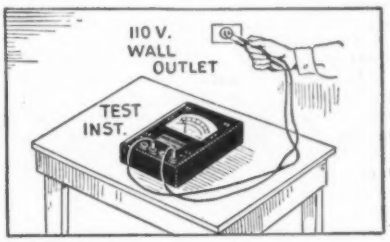


Fig. 1—Different readings when meter ranges are switched is no proof of inaccuracy.

circuits into which it is connected in any way that would cause an inaccurate or fictitious reading.

This has been repeatedly explained in detail in radio literature, but one caution deserves restatement here: take receiver voltage measurements *only* with a sensitive voltmeter of high enough resistance that its "shunting" effect causes very little change in the measured voltage. This is especially important when checking voltages in a.v.c. and other high-resistance circuits.

A good rule to remember when using a voltmeter is:

When making voltage measurements, the resistance of the voltmeter used (for the particular range employed) should be at least 10 times the resistance of the circuit across which it is connected.

Practical, portable voltmeters, with a D.C. sensitivity as high as 20,000 or 25,000 ohms-per-volt, have been commercially available for several years. When higher sensitivity is required, use a vacuum-tube voltmeter.

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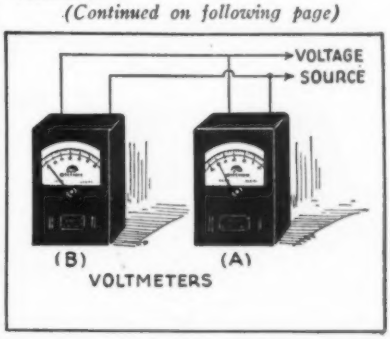

Fig. 2—Checking a meter with one of equal or less accuracy produces no useful result.

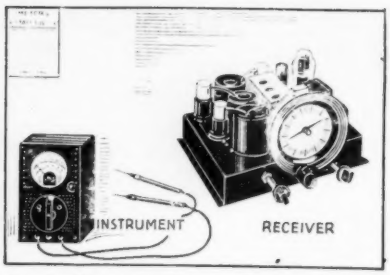

Fig. 3—This is another excellent method of getting wrong results in checking the meter.

CIRCUIT FLUCTUATIONS

If the value of the observed quantity varies or fluctuates while the instrument is being read, the reading probably will be inaccurate, because then the exact pointer position cannot be accurately determined.

This can occur when checking current or voltages in a receiver connected to a power line whose voltage fluctuates. Obviously, measurements under these adverse conditions may be very inaccurate—due to no fault of the electrical measuring instrument. Make the measurements as carefully as possible—allowing for the possible inaccuracy when interpreting the readings.

Sometimes the measurement fluctuates because of a poor connection in the circuit or device under test (or in the test instrument) which erratically changes the resistance, voltage and current in the circuit. This is a definite fault which should be traced and corrected before any further measurements are made. Often, corrosion at the ends of the test prods, at the pin jacks or between switch contacts will cause such intermittent connections. If the resistance is sufficient to be even 2% of the value of the circuit resistance under test, and if the contact resistance changes value momentarily, it may readily cause fluctuations in the instrument reading. Such fluctuations will cause inaccurate readings to be taken. The remedy is obvious.

WRONG INSTRUMENT RANGE

The importance of using proper instrument ranges for all measurements, and the errors which result if this practice is not followed were explained in detail previously, so little more need be said about this here. It should be remembered that the error, expressed as a percentage of the observed quantity, can be appreciable if the range selected is such that the reading is being taken far down at the lower portion of the scale.

INCORRECT CHECKING METHODS

Service men often suspect their indicating instruments of having developed large inherent errors and then, not having available accurate standard instruments with which to compare them, they proceed to check their accuracy by makeshift methods. Such tests usually are misleading and lead to incorrect conclusions. As a result of them, unjust complaints about the accuracy of test instruments often are made to instrument manufacturers—complaints which indicate incomplete knowledge of the subjects of instrument characteristics and accuracy. In this connection, a few simple rules should be followed:

Do not Check Several Ranges on One Current or Voltage Source.

A favorite complaint is that though the same 110-volt house or shop voltage supply is used to test all A.C. voltage ranges of the instrument, a different reading is obtained on each range; therefore, the instrument is not accurate. See Fig. 1.

Why is it possible to obtain a different reading on each range of a perfectly good, accurate A.C.-D.C. voltmeter, even though the applied voltage is exactly the same each time?

Assume that the instrument, with ranges of, say, 0/7/34/140/350/700/1400 volts, has the usual 2% accuracy rating for D.C. voltage measurements and 5% for A.C. measurements. Since a 110-volt *A.C.* line is being used as the voltage source for checking, the 5% accuracy figure is the one that will apply. Remember that the manufacturer's guarantee that the instrument is accurate within 5% on A.C. means that on each range it is accurate to within ± 5% of the full-scale value *of that range*. On the 7-volt range, for instance, this means that the instrument is accurate to within plus or minus 0.35 volt (5/100 × 7) at any point on the scale; similarly the tolerance on the 35-volt range is plus or minus 1.75 volts (5/100 × 35), etc.

The *permissible* reading variation limits for the remaining ranges, for ± 5% tolerance, has been calculated and tabulated herewith:

RANGE	READING LIMITS *(For ± 5% Voltage Tolerance)*
7 V.	± 0.35 V.
35 V.	± 1.75 V.
140 V.	± 7.00 V.
350 V.	± 17.5 V.
700 V.	± 35.0 V.
1,400 V.	± 70.0 V.

Since the instrument is accurate to within ± 5%, when the 140-volt range is connected to check the voltage of the 110-volt A.C. supply line, the instrument indication may properly be anything between 103 and 117 (110 minus 7 volts, and 110 plus 7 volts). If the 350-volt range is connected to check the same 110-volt source, the instrument may properly indicate anywhere between 92.5 and 127.5 volts. (110 minus 17.5 volts, and 110 plus 17.5 volts.) On the 700-volt range, the indication could properly be anywhere from *75* to *145* volts and still be within the proper tolerance. If any such readings were obtained during the test, the instrument could not properly be considered as being below its specified accuracy. If the service man does complain that such an instrument is excessively inaccurate, *the fault lies not with the instrument, but with himself*. He is not allowing for the fact that the higher the instrument range employed, the larger is the permissible difference between the true value of the voltage being measured and the voltage *indication* or *reading* obtained.

"Why didn't the Signal Corps think of this when we were at Salerno!"

When comparing the reading obtained when a quantity is measured using one range with that obtained when the same quantity is measured on a different range, the service man should also remember that the scale error on one range may be *plus*, while that on the other range may conceivably be *minus*. Thus, if the errors oppose each other, the difference between the readings obtained on the two scales will be equal to the algebraic *sum* of the two errors.

Similarly, if the voltage existing in some particular circuit of a radio receiver is checked on two or more different ranges of a voltmeter, it should be remembered that additional apparent discrepancies may be introduced by the fact that each range places a different amount of loading upon the receiver circuit being measured. For example, due to the fact that the series multiplier resistor in the 500-volt range circuit of a voltmeter has much higher resistance than that in the 150-volt range circuit, the voltmeter draws more current from the receiver circuit under measurement when the 150-volt range is used than if the 500-volt range is used to measure the same voltage. Therefore, any error caused by the "loading" effect of the voltmeter would be greater when the *lower* range is used.

With these important facts in mind, it is easy to understand the fallacy of checking the accuracy of several ranges of a multi-range instrument by connecting them, in turn, to one voltage (or current) source and expecting the reading to be exactly the same on each range.

Do Not Check An Instrument Against Another of Equal, or Lower, Inherent Accuracy.

Another incorrect method of checking an instrument, practiced by some service men, is illustrated in Fig. 2. The reading on the instrument to be checked *(A)*, is compared with that on *another instrument (B) which has no better accuracy rating than the instrument under test.*

First, the ranges on the so-called "comparison" indicating instrument used may be quite dissimilar to those of the instrument tested; of course, this alone can cause wide differences in the readings of the two. Even if the ranges are similar, the readings probably will differ because the two instrument inaccuracies are not similar at various scale points. For example, if the error at the 2-volt point on the scale of one instrument is 0.1 volt, there is no reason to believe that exactly the same error exists at the 2-volt point on the other instrument. It may be *more*—or *less* even though both instruments have the same accuracy rating. Errors may be in opposite directions on the two instruments compared. The differences may be as much as 50% or 60% of the reading if it is taken on the more-or-less inaccurate lower end of the scale. The percentage accuracy rating of an instrument does not tell exactly what the error *is* at each point on the scale—it tells only that the error *does not exceed* a certain amount. Therefore, since the "comparison" instrument has no higher accuracy than the one under "test," one should not be compared with the other nor judged by the other.

Checking one instrument against another is a reliable accuracy test only when the

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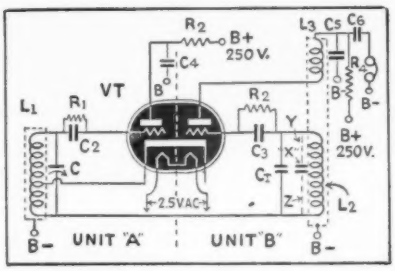

Fig. 1—The first set-up, using a single 53.

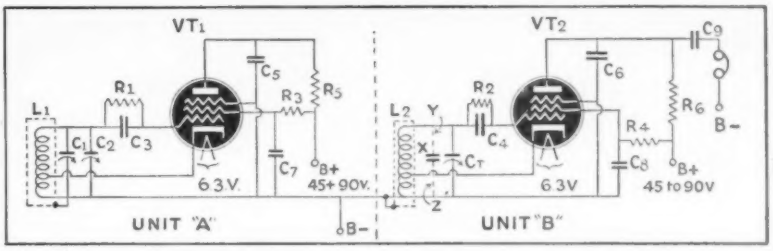

Fig. 2—A better combination, using two electron-coupled oscillators to avoid coupling.

An Electronic CAPACITY METER

By HERBERT R. MICHAELSON

Instruments for measuring the capacity of small condensers are not commonly available to the average technician. Such meters are very useful, and their importance will increase as radio moves farther into the higher frequencies, where slight changes of capacity have large effects. The instrument described is simple, easily constructed and accurate.

THE technician, experimenter, or repairman finds many uses for a capacity meter. Most commercial meters are expensive, and often not accurate for small measurements, such as interelectrode capacities. The popular and economical capacity bridge is not ideal for measuring very small capacities, because of the compensation required and because of its physical limitations. The electronic meter described here is simple and inexpensive to construct, and is accurate to within a *hundredth of a micromicrofarad* or better, depending on the size of the calibrating condenser and accuracy of the vernier dial used. The range of the meter is 0-350 mmfd. Such precise method of measuring small condensers has several interesting and useful applications. For example, it is well adapted to measuring interelectrode capacities.

The current scarcity of radio tubes creates a problem where a pair of "matched" tubes is needed. In R.F. push-pull stages of U.H.F. transmitters or even in high-fidelity A.F. amplifiers, perfectly matched tubes are generally required. When several tubes of the same type are available, the two whose interelectrode capacities are found to be most nearly alike, should be selected.

Another obvious use for this capacity meter is checking the values of small fixed condensers. Also, it is often desirable to know the minimum and maximum values of variable condensers, or to calibrate their dials. When designing an inductor for a tuned circuit, it is helpful to know the exact capacity of the variable condenser at any given setting. The meter can also be used to measure the capacity between a coil and its shield, and the shield can be adjusted or replaced until a desirable smaller capacity is achieved. The same holds true of inter-stage capacitative coupling between wires, which causes spurious oscillations. This coupling can be reduced by measuring this capacity between coils or parts, and moving or shielding them until the meter shows a desirable minimum.

The shielding of R.F. leads may result in considerable losses. This wire-to-shield capacity may be only a few mmfd., but can be measured with the meter and this value compared with other similarly shielded wires. If the capacity is too high, flexible shielding may be loosened until a suitable smaller capacity exists, reducing R.F. losses.

A great variety of other useful measurements can be made with this apparatus, including antenna-to-ground capacity, interelectrode capacities of ganged switches, sockets, etc. Troublesome R.F. losses can often be avoided by the use of low-capacity sockets and switches.

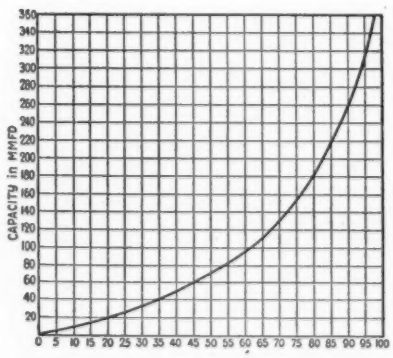

Fig. 3—Calibration curve of the first unit.

A BALANCING DEVICE

This meter operates on the principle of capacity substitution. In Fig. 1, there are two triode oscillators, which will resonate at the same frequency if the tuning condensers in their tank circuits have the same capacity. If an unknown condenser is placed at "X," variable condenser "C" can be adjusted until the two circuits resonate at the same frequency. Unit "B" is used as an oscillating detector, with earphones in the plate circuit. When the two oscillators approach the same frequency, an audio beat note is heard in the earphones. At zero beat, a reading is taken on the calibrated dial of "C," and the unknown capacity "X" can be accurately determined.

The twin-triode 53 tube was used in the simple capacity meter in Figure 1. At first, *both* oscillators were of the modified series-fed Hartley type of unit "A." However, the common cathode circuits resulted in the two units functioning as a single oscillator. Therefore, unit "B" was changed to an Armstrong oscillator, as shown in Fig. 1. The two units now functioned independently. Coils L_1 and L_2, in this case, covered the broadcast band when a 365 mmfd. variable condenser was used at "C" or "X." The inductance of the coils was not critical; identical coils of any convenient frequency range could have been used.

Trimmer "C_T" was adjusted so that its capacity was the same as the *minimum* capacity of "C." Zero-beat was then obtained when condenser "C" was completely open, and with no condenser at "X." This was the first step in calibrating "C," which will be explained in detail later on.

Excess coupling between the two units

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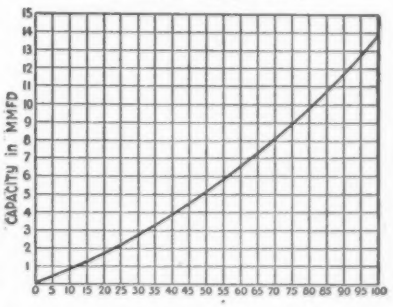
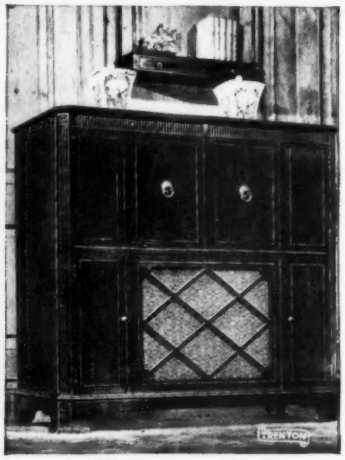


Fig. 4—Final calibration of the 2-tube meter.



The Zenith 14H697 is a 14-tube receiver (including microphone amplifier and electron-ray indicator tubes) combining AM and FM reception, with I.F.'s of 8.3 Mc. and 455 Kc.

ZENITH RADIO

MODEL 14H697

LINE VOLTAGE.....117 A.C. 60 CYCLE

POWER CONSUMPTION.....115 WATTS

PHONO MOTOR.....35 WATTS ADDITIONAL

MAXIMUM AUDIO POWER OUTPUT.....15 WATTS

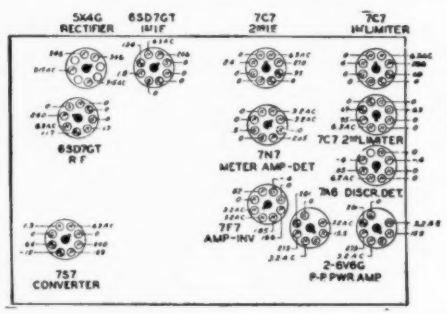
STAGE GAINS Bc. and I.F.	TUNING RANGES
Ant. to R.F. grid 8X at 1000 Kc.	540 to 1620 Kc.
R.F. grid to conv. grid 7X at 1000 Kc.	
Conv. grid to I.F. grid 40X at 455 Kc.	5.6 to 18.4 Mc.
Overall audio 1850X at 1 watt, 400 cycles.	42 to 50 Mc. (F.M.)

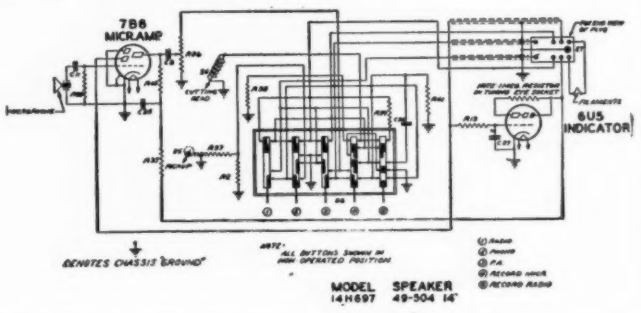
ALIGNMENT PROCEDURE

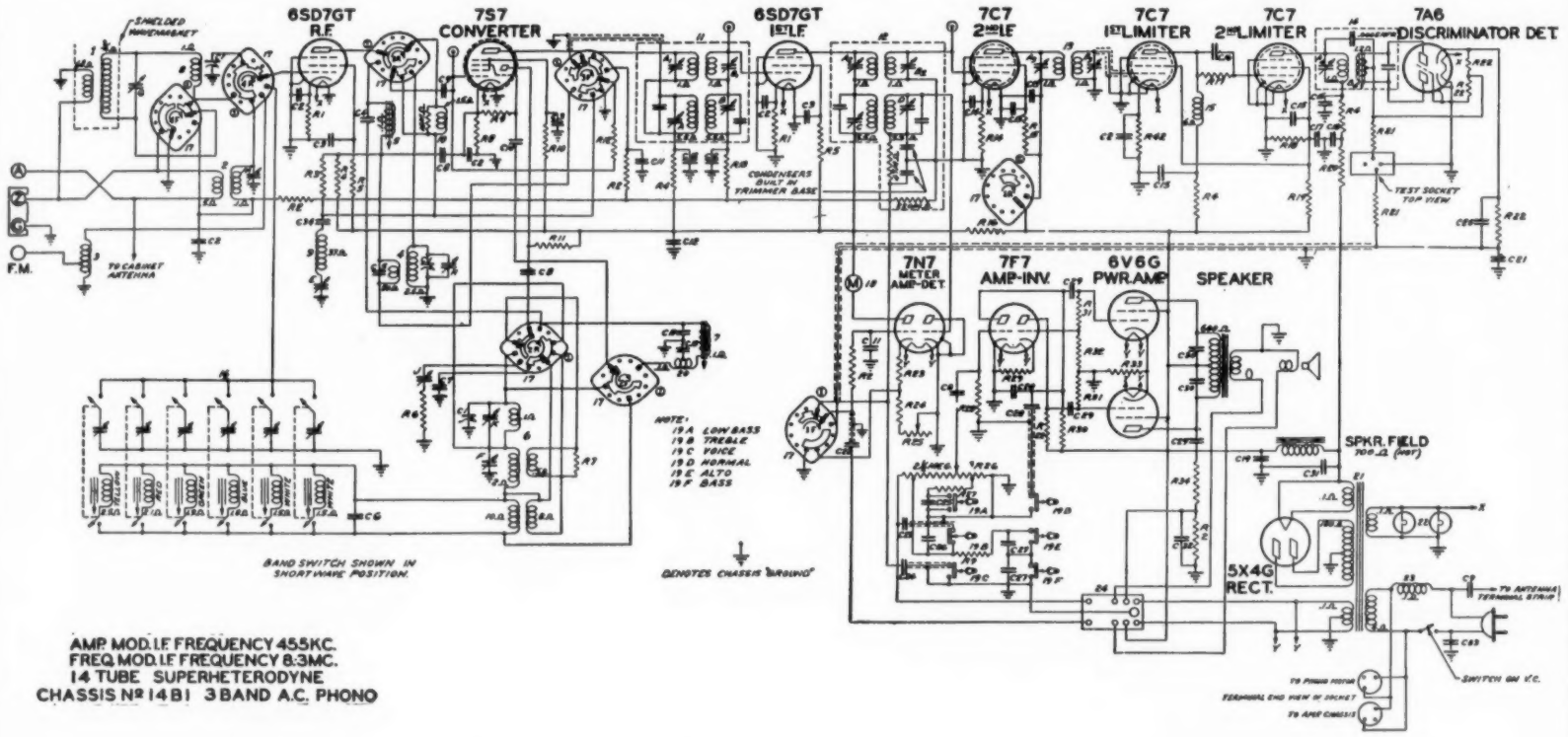
Operation	*Connect Oscillator to*	*Dummy Antenna*	*Input Signal Frequency*	*Band*	*Set Dial At*	*Trimmers*	*Purpose*
1	Conv. grid	.5 mfd.	455 Kc.	BC	600 Kc.	A, B, C, D	Align BC I. F.
2	R.F. grid	"	"	"	"	E	I.F. trap for min. I.F. sig
3	Ant. Gnd.	400 ohm	18 Mc.	SW	18 Mc.	K	Scale osc. at 18 Mc.
4	"	"	15 Mc.	"	15 Mc.	M	Align SW antenna
5	ONE TURN		1600 Kc.	BC	1600 Kc.	F	Set BC osc. to scale at 1600 Kc.
6	LOOP WITH		1400 Kc.	"	1400 Kc.	H	Align BC to R.F. stage
7	GENERATOR		1400 Kc.	"	1400 Kc.	G	Align BC loop
8	LEADS		600 Kc.	"	600 Kc.	J	Rock gang to track BC padder
9		.5 mfd.	8.3 Mc.	FM	42.5 Mc.	A_4	Align for maximum deflection across ½ discrim. load
10	7C7 2nd I.F. Grid Pin	"	"	"	"	B_4	Zero deflection across full discrim. load. Repeat operation 9
11	Jack III	"	"	"	"	A_3-B_3	Align for maximum deflection across ½ discrim. load
12	65D7 1st I.F. grid Pin Jack III	"	"	"	"	A_2-B_2	Align for maximum deflection across ½ discrim. load
13	Conv. grid Pin Jack I	"	"	"	"	A_1-B_1	Align for maximum deflection across ½ discrim. load
14	F.M. Ant. Ter.	100 ohms	46 Mc.	"	46 Mc.	Adjust osc. cam gang shaft to scale osc.	Align for zero deflection across full discrim. load
15	"	"	"	"	"	Adjust R.F. cam for F.M. tracking	Align for max. deflec. across ½ discrim. load
16	Adjust Tuning Meter			"	Clear of Signals	Bias control	Adjust bias for tuning meter

Remove the 2nd I.F. tube (7C7) from its socket. Adjust bias control until the meter reads exactly at its center point. Replace the I.F. tube which was removed and check meter behavior on both F.M. and A.M. signals.

All voltages measured with a 20,000 ohm per volt meter from chassis to socket contact indicated. All voltages are positive D.C. unless marked otherwise. Volume control full on.







AMP. MOD. I.F. FREQUENCY 455 KC.
FREQ. MOD. I.F. FREQUENCY 8.3 MC.
14 TUBE SUPERHETERODYNE
CHASSIS Nº 14B1 3 BAND A.C. PHONO

Diag. No.	Description	
C1	Three Gang Variable	
C2	.05 Mfd.	200 V.
C3	.01 Mfd.	400 V.
C4	5 Mmfd. Comp	
C5	.00025 Mfd.	600 V.
C6	Compensating Cond.	
C7	.005 Mfd.	1000 V.
C8	.002 Mfd.	600 V.
C9	.0001 Mfd.	600 V.
C10	50 Mmfd.	600 V.
C11	.01 Mfd.	200 V.
C12	.05 Mfd.	400 V.
C13	100 Mmfd. Comp.	
C14	.005 Mfd.	200 V.
C15	.005 Mfd.	600 V.
C16	25 Mmfd.	600 V.
C17	5 Mfd. Electrolytic	200 V.
C18	15 Mfd. "	250 V.
C19	30 Mfd. "	450 V.
C20	.0005 Mfd.	600 V.
C21	.002 Mfd.	600 V.
C22	.2 Mfd.	200 V.
C23	75 Mmfd.	600 V.
C24	.005 Mfd.	600 V.
C25	.02 Mfd.	400 V.
C26	.00015 Mfd.	600 V.
C27	.01 Mfd.	400 V.
C28	.004 Mfd.	600 V.
C29	.02 Mfd.	600 V.
C30	.002 Mfd.	1000 V.
C31	30 Mfd. Elect. or-22-1294	450 V.
C32	.0005 Mfd.	600 V.
C33	.005 Mfd.	600 V.
C34	.001 Mfd.	600 V.
R1	150 Ohm	½ W.
R2	2.2 Megohm	½ W.
R3	10M Ohm	1 W.
R4	1000 Ohm	½ W.
R5	39M Ohm	1 W.
R6	15 Ohm	½ W.
R7	4700 Ohm	½ W.
R8	180 Ohm	½ W.
R9	47M Ohm	½ W.
R10	180M Ohm	½ W.
R11	15M Ohm	1 W.
R12	470M Ohm	½ W.
R13	1 Megohm	½ W.
R14	680 Ohm	½ W.
R15	270M Ohm	½ W.
R16	1000 Ohm	1 W.
R17	1.5 Megohm	½ W.
R18	15M Ohm	½ W.
R19	33M Ohm	1 W.
R20	82M Ohm	2 W.
R21	47M Ohm	½ W.
R22	100M Ohm	½ W.
R23	1800 Ohm	½ W.
R24	600 Ohm	½ W.
R25	Bias Control	
R26	Volume Control	
R27	47M Ohm	½ W.
R28	15 Megohm	½ W.
R29	2200 Ohm	½ W.
R30	220M Ohm	½ W.
R31	330M Ohm.	½ W.
R32	15M Ohm	½ W.
R33	200 Ohm	2 W.
R34	330M Ohm	½ W.
R42	1500 Ohm	½ W.
1	Wave Magnet	
2, 3	Antenna Coil Assem.	
4	Detector Coil Assem. (A.M.)	
5	Detector Coil Assem. (F.M.)	
6	Oscillator Coil Assem. (A.M.)	
7	Oscillator Coil Assem. (F.M.)	
8	Loop Loading Coil	
9	Wave Trap	
10	Coil & Res. Assembly	
11	1st I.F. Transformer	
12	2nd I.F. "	
13	3rd I.F. "	
14	Discriminator I.F. Trans. (F.M.)	
15	Plate Choke	
16	Automatic Tuning Unit	
17	Band Selector Switch	
18	Tuning Meter	
19	Tone Control Sw. Assem.	
20	Peaking Coil	
21	Pwr. Trans. 117 V. 50-60r	
22	Dial Light 6.3 V. .25A.	
23	Line Choke	
24	Connector Socket	
A	1st I.F. Trans Pri.	
B	1st I.F. Trans Sec.	
C	2nd I.F. Trans. Pri.	
D	2nd I.F. Trans. Sec.	
A1	1st I.F. Trans. Pri. (F.M.)	
B1	1st I.F. Trans. Sec (F.M.)	
A2	2nd I.F. Trans. Pri. (F.M.)	
B2	2nd I.F. Trans Sec. (F.M.)	
A3	3rd I.F. Trans Pri. (F.M.)	
B3	3rd I.F. Trans Sec. (F.M.)	
A4	Discriminator I.F. Trans. Pri.	
B4	Discriminator I.F. Trans. Sec.	
E	Wave Trap	
F	Broadcast Osc. (Note 1)	
G	Broadcast Ant. (Note 2)	
H	Broadcast Det. (on Gang)	
J	Broadcast Padder	
K	Shortwave Osc. (Note 1)	
M	Shortwave Ant (Note 2)	
Note: (1)	Trimmers F & K Are Mounted on Strip #22-1045	
(2)	Trimmers G & M Are Mounted on Strip #22-1033	

Left—Parts list of the schematic diagram shown above. Below—parts list of the microphone amplifier shown on facing page.

Diag. No.	Description	
C8	.02 Mfd.	600 V.
C11	.01 Mfd.	200 V.
C25	5 Mfd. Electrolytic	300 V.
C26	.001 Mfd.	600 V.
C37	.1 Mfd.	200 V.
R2	2.2 Megohm	½ W.
R13	1 Megohm	½ W.
R28	15 Megohm	½ W.
R35	100M Ohm	½ W.
R36	Volume Control	
R37	220M Ohm	½ W.
R38	20 Ohm	1 W.
R39	38 Ohm	1 W.
R40	220M Ohm	½ W.
R41	100M Ohm	½ W.
24	Cutting Head	
25	Pickup Cartridge	
26	Recorder Control Sw.	
27	Connector Plug	

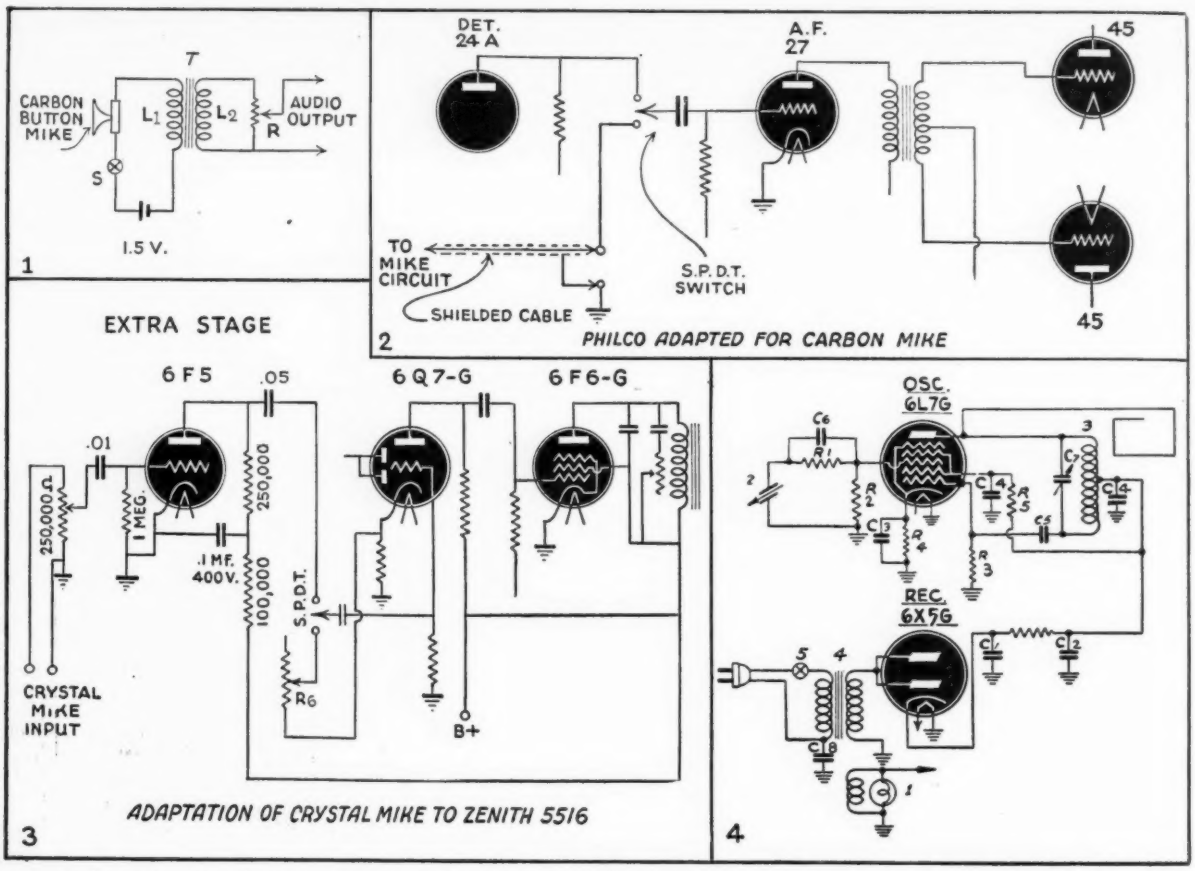


Fig. 1—The carbon microphone requires only a dry cell and microphone transformer. The output terminals may be plugged into a radio's "phono" jack. Fig. 2—How a microphone may easily be connected to any typical radio. Fig. 3—The crystal microphone usually needs one stage of pre-amplification. Fig. 4—The "wireless" phono oscillator has its own power pack; requires no connection to the radio.

How to Attach a MICROPHONE TO YOUR SET

By JACK KING

THERE is a great deal of interest in adding "mikes" to radios. How the job can be done in a number of representative cases is our theme here. First, of all the types of mikes available, probably the easiest to get working is the old carbon button variety. The single button carbon mike has the highest output voltage, but the quality will not be as good as that obtained with a double button unit or one of the more modern types such as the crystal or dynamic.

A simple hook-up for a single-button carbon button mike is shown in Fig. 1. The value of R may be 250,000 ohms. In the average circuit, with the mike connected to the radio receiver, the load impedance will be about 100,000 ohms. The transformer may have a turns ratio of about 30 to 1, step-up, for a 100 ohm mike. About .13 volt may be obtained across the primary and 4 volts across the secondary. (Steady whistle at 1 ft. distance into mike.) The output level of such a mike will be about —15 db. (reference to .006 watt). If the bias on the first audio amplifier tube is 5 or 6 volts the tube will be swung to fill output on peaks. (4 × 1.4 equals 5.6).

Voltage on carbon microphones should be kept as low as feasible to get good signal volume. They are commonly run underloaded, with one dry cell (flash-light battery) on this job, but if the sound is not loud enough, a second cell can be used. Consult the manufacturer's specifications in such cases, and use a rheostat (about 500 ohms).

A hookup for the Philco 76 is shown in Fig. 2. (This adaption can be used for a record player as well as a mike. The mike cable should be shielded and the mike itself must be turned on its axis so that a minimum of sound from the radio loudspeaker reaches it. It is usually best to use the mike in one room and the radio in another to prevent howling. Acoustic feedback occurs when the loud-speaker sound gets into the mike and is re-amplified.

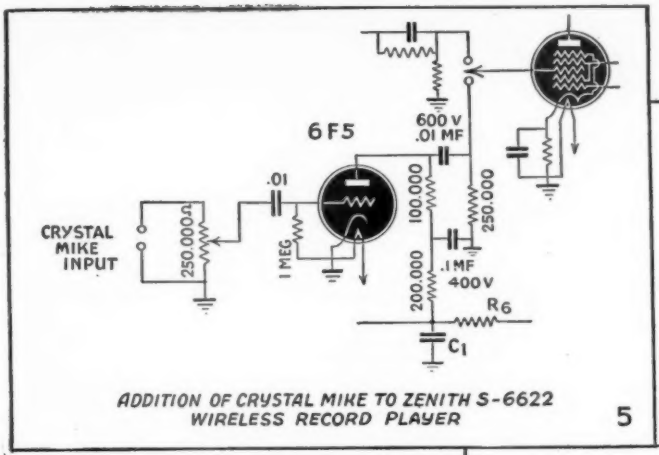
The same principle can be used in connecting any type of microphone to almost any standard radio set. In sets using a diode-triode or diode-pentode tube as detector and first audio amplifier, the switching circuit is of course placed in the lead to its grid. In some cases, the volume control in the set can be used in place of R in Figure 1. The switch would then have its center arm connected to the "top" end of the volume control, and would switch it to either the return lead of the diode circuit (normal radio position) or to the microphone input.

The crystal mike has a high impedance, so it is impractical to use a step-up transformer for boosting the gain. Instead, an additional stage of amplification can be added. The power for operation of the stage is derived from the radio itself. Fig. 3 shows a hookup of a crystal mike to a modern receiver. The output of a crystal mike varies according to the type and manufacturer, ranging from —55 to —90 db., with 60 db. being an average figure. (.006 watt reference level).

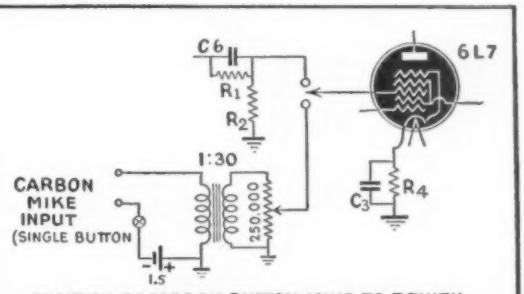
The extra stage of amplification will give plenty of gain, so that you don't need to bellow into the mike in order to get a good output signal. The quality of reproduction will be better than that obtained with the carbon button mike.

The tube can be mounted on a small chassis of steel, or aluminum if you can get it, and the chassis can be screwed to the inside of the cabinet. A shielded wire can be run from the 6F5 plate to the single pole double throw switch and similarly shielded wires run to the volume control and 6Q7

Figs. 5 and 6—Method of adding carbon or crystal microphones to two well-known radio circuits. The crystal mike may be applied to Fig. 6 as well, or the carbon to Fig. 5.



ADDITION OF CRYSTAL MIKE TO ZENITH S-6622 WIRELESS RECORD PLAYER 5



ADDITION OF CARBON BUTTON MIKE TO ZENITH WIRELESS RECORD PLAYER S-6622 6

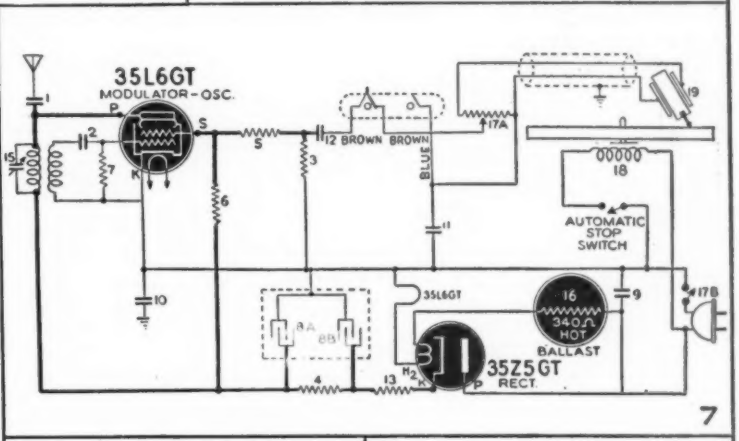
grid. Any high gain triode can be used, such as the 6K5, 6Q7 or 6F5-GT.

In many cases a wireless record player is available and the owner wants to have a mike added to it in place of the phono arm or as an extra gadget. If a crystal mike is used, additional gain will be required. Fig. 4 shows a typical record player of good quality. The circuit may be modified slightly as in Fig. 5 for the addition of a mike. If a single button carbon mike is used the circuit of Fig. 1 can be used to work directly into the recorder player without any need for an extra pre-amplifier stage. The change involved is illustrated in Fig. 6.

Where the wireless record player is an A.C.-D.C. type it is not convenient to add an extra tube for amplification of the signal derived from the microphone circuit, and the single button carbon mike is used because of the ease of hooking it up. In Fig. 7 a typical record player of the A.C.-D.C. type is shown. Fig. 8 shows the circuit used, when a carbon mike is added. Fig. 9 shows a double button carbon mike installation. The double button type has better fidelity but considerably lower output. The coupling transformer should have a turns ratio such that the voltage step-up is about 30 to 1 for 100 ohm buttons. In general it is better to use the carbon mike and a coupling transformer with A.C.-D.C. circuits to keep the 115 volt line voltage away from the untrained user of the mike (the average set owner) which will avoid danger of electrical shock. Because the crystal type is high impedance and connects directly to the circuit it is unsuitable for A.C.-D.C. jobs. Such a mike could be coupled through a 1:1 ratio transformer, however.

As the carbon mike has high output, it eliminates the need for additional pre-amplification. If a pre-amplifier tube is added it will be necessary to supply the filament through a separate voltage dropping resistance, since it is not possible to hook directly into the set without disturbing the receiver circuit. The filament circuit of an A.C.-D.C. set would be upset by the addition of an extra filament. This trouble may be avoided using the carbon mike. In adding a mike it is realized that the gadget is purely for entertainment purposes and not capable of high fidelity, such as would be required in making recordings or in public address jobs of high grade.

How a crystal mike may be added to an A.C.-D.C. set is shown in Fig. 10. The 1:1 ratio transformer is needed to isolate the mike from the power line.



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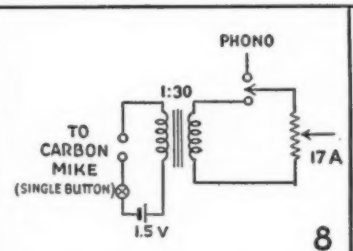

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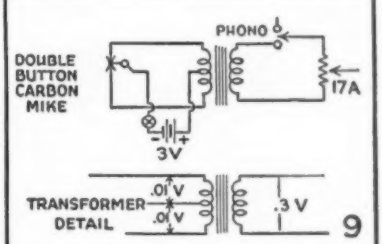

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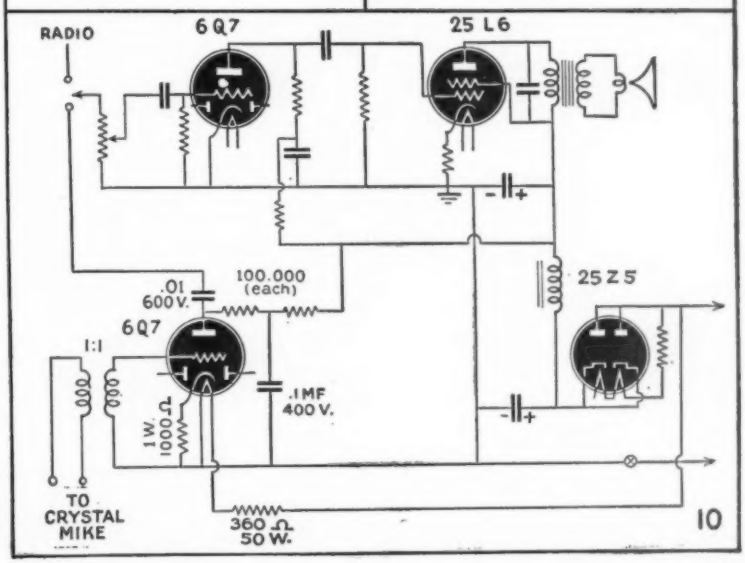

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Fig. 7—The Stewart-Warner wireless record player 11-2A. Fig. 8—How a carbon mike may be attached to it. Fig. 9—Connections for double-button microphone. Fig. 10—Circuit for adding crystal mike to an A.C.-D.C. set.

World-Wide Station List

Edited By ELMER R. FULLER

RECEPTION during the past few weeks has not been very good, but it should improve as we get into the dead of winter. On several occasions lately, the bands have been very good for a short time, and then they suddenly die out and nothing more is heard. In spite of this, several good catches have been possible. The best bet is "Radio Brazzaville" and O P L, Leopoldville, Belgian Congo. The former is on 11.970 megacycles from 4:45 to 8 pm; and the latter is on 9.785 megacycles from 5:45 to 6:35 pm and 8:15 to 8:45 pm, daily.

The British Broadcasting Corporation has added another station to its North American Service. This is on 2.926 megacycles from 7 pm to 12:45 am. Reception from this station has been very good during the early and late evenings for the past couple of weeks, and will probably continue as such until late spring when these frequencies become noisy during the early hours of evening. Other stations now in the North American Service are G S C on 9.58 mcs.; G S U on 7.26 mcs.; G S L on 6.11 mcs.; G R W on 6.15 mcs.; G S W on 7.23 mcs.; and G R J on 7.32 mcs.

A station located in Bern, Switzerland, is now being heard during the evening around 9 pm, on 7.210 megacycles. In the morning from 9 to 9:30 am, M T C Y, in Hsinking, Manchuria has been heard recently. This is a good catch if you can pull it in. They have also been reported as being heard at other times from midnight to 10 am.

On a frequency of 7.020 megacycles, Ponta Delgada, Azores has been heard on Sunday afternoon from 4 to 5 pm. They have a program of music with a news broadcast now and then.

With deep regret it is announced that the closing down of the Bermuda Broadcasting Board of Hamilton, Bermuda, took place on December 31st, 1943. Station ZFA3 operating on 3.352 megacycles, formerly ZFA and ZFA2, is off the air indefinitely, due to an act passed by the Colonial Government at Hamilton. After a very complete ceremony, ZFA3 went off the air at 8:25 pm, E.W.T. We feel sure that many readers will miss this transmitter.

May we call your attention to WWV of Beltsville, Maryland, operated by the United States Bureau of Standards on 5.000 megacycles. This station, operated by the federal government broadcasts daily, the standard of frequency, time, and musical pitch. It also broadcasts the frequency test signals every hour on 10,000 megacycles.

Many of the underground stations have changed their times of transmission and their frequency during the past few weeks. These changes have been noted in our station list. Next month, we will endeavor to present our station list in a new form in answer to requests from several of our readers.

Reports for the past month have been received from the British Broadcasting Corporation; William E. Duggan, Jr.; Burnell Thrasher; Gilbert L. Harris; James S. Messler; Royal M. Gibson; Bill Buehrle, Jr.; and Joseph Miller.

All schedules below are Eastern War Time.

Mc.	Call	Location and Schedule
2.926	GRC	LONDON, ENGLAND; North American Service, 7 pm to 12:45 am.
4.020	——	PONTA DELGADA, AZORES; 6 to 8:01 pm.
4.107	HCJB	QUITO, ECUADOR; 7:45 to 10 am; 8 to 10 pm; daily except Mondays; Sundays, 9 am to 8 pm.
4.70	ZQI	KINGSTON, JAMAICA; Sunday, 6:15 to 6:55 pm; daily, 6:15 to 7:15 pm.
4.75	YV1RV	MARACAIBO, VENEZUELA.
4.76	YV4RO	VALENCIA, VENEZUELA
4.765	HJFB	MANIZALES, COLOMBIA.
4.77	YV1RY	CORO, VENEZUELA
4.78	YV3RN	BARQUISMETO, VENEZUELA
4.79	YV6RU	BOLIVAR, VENEZUELA; evenings.
4.92	YV5RN	CARACAS, VENEZUELA; evenings.
4.955	HJCQ	BOGOTA, COLOMBIA; evenings.
5.000	——	WASHINGTON, D. C.; U. S. Bureau of Standards; Standards of frequency; time, and musical pitch.
5.620	OAX2A	TRUJILLO, PERU; heard Sundays 7:30 to 8 pm
5.75	PZX	PARAMARIBO, DUTCH GUIANA; Friday, 7 to 7:30 pm.
5.875	HRN	TEGUCIGALPA, HONDURAS; 7 pm to midnight; Sundays, off at 10:45 pm.
5.935	PJCI	CURACAO, NETHERLANDS WEST INDIES; 7:45 to 10:38 pm
5.980	VONH	ST. JOHNS, NEWFOUNDLAND; Sundays 8:30 to 10:30 am; 1:30 to 6 pm; other days, 6:30 to 10:30 am; 2:30 to 7:30 pm.
6.000	HH2S	PORT AU PRINCE, HAITI; 7:35 pm Saturdays.
6.005	CFCX	MONTREAL, CANADA; Sunday, 7:30 am to 12 midnight; Monday to Saturday, 6:45 am to 12 midnight.
6.010	GRB	LONDON, ENGLAND; evenings.
6.010	CJCX	SYDNEY, NOVA SCOTIA; Monday to Friday, 7 to 11 am; Saturday, 6:45 to 11 am; Sunday, 8 to 11 am.
6.020	ZFY	GEORGETOWN, BRITISH GUIANA; evenings.
6.030	CFVP	CALGARY, CANADA; Sunday, 10 am to 1:30 am; Monday, to Saturday, 8:30 am to 2 am.
6.03	DXP	BERLIN, GERMANY; North American beam, evenings to 1:30 am.
6.040	WRUW	BOSTON, MASSACHUSETTS; European beam, 2:15 to 4 am; Central American beam, 7:30 pm to 2 am.
6.05	GSA	LONDON, ENGLAND.
6.0[illegible]	WCDA	NEW YORK CITY; Mexican beam, 7:30 pm to 2 am.
6.0[illegible]5	SBO	MOTALA, SWEDEN; European beam, 5:15 to 5:50 pm; North American beam, 9 to 10 pm.
6.070	CFRX	TORONTO, CANADA; Sundays, 9 am to midnight; Monday to Friday, 7:30 am to 12:05 am; Saturday, 7:30 am to 12:45 am.
6.080	WLWK	CINCINNATI, Ohio; European beam, 12:15 to 4:30 am; West South American beam, 8:30 pm to midnight.
6.090	CBFW	VERCHERES, CANADA; daily, 7:30 to 11:30 pm (in French).
6.09	ZNS2	NASSAU, BAHAMAS; Sundays, off at 10:05 pm.
6.095	OAX4H	LIMA, PERU.
6.105	HJFB	MANIZALES, COLOMBIA; 9 to 10 pm.
6.11	GSL	LONDON, ENGLAND; American beam, 5:15 pm to 12:45 am.
6.120	WCRC	NEW YORK CITY; European beam, 12:15 to 2:45 am.
6.120	WKTS	NEW YORK CITY; European beam, 3 to 5 am; 8 pm to midnight.
6.120	——	BERLIN, GERMANY; North American beam, variable times.
6.120	LRX1	BUENOS AIRES, ARGENTINA; "Radio El Mundo"; 9 to 12 pm.
6.130	COCD	HAVANA, CUBA; 9 pm to 1 am.
6.130	XGOY	CHUNGKING, CHINA; East Asia and South Seas; 7:35 to 9:40 am; North American beam, 9:45 to 11:30 am.
6.130	CHNX	HALIFAX, NOVA SCOTIA; Sundays, 8 am to 6:55 pm; Monday to Thursday, 6:45 am to 10:15 pm; Friday, and Saturday, 6:45 to 11 am.
6.140	WBOS	BOSTON, MASS.; European beam, 3:45 to 5:45 am.
6.140	DXX	BERLIN, GERMANY; 7 to 8 pm.
6.145	HJDE	MEDELLIN, COLOMBIA; 9 to 11 pm.
6.150	CJRO	WINNIPEG, CANADA; 9 pm to 1 am.
6.150	GRW	LONDON, ENGLAND; North American beam, 10:15 pm to 11:30 pm.
6.160	HJCD	BOGOTA, COLOMBIA; 9 to 10 pm.
6.160	CBRX	VANCOUVER, CANADA; 10:30 am to 2:30 am.
6.165	HHBM	PORT AU PRINCE, HAITI; 7 to 10 pm.
6.170	WCBX	NEW YORK CITY; European beam, 11:45 pm to 3 am.
6.180	HJCX	BOGOTA, COLOMBIA; 7 pm to 12:15 am.
6.190	DXG	BERLIN, GERMANY.
6.190	WGEO	SCHENECTADY, NEW YORK; 12:15 to 3:15 am; European beam.
6.200	ZYC7	RIO DE JANEIRO; never heard, as yet.
6.20	GRN	LONDON, ENGLAND; 8:15 pm to 12:45 am.
6.2	YV5RN	CARACAS, VENEZUELA; early evenings.
6.220	——	"GUSTAV SIEGFRIED EINS"; 7:50 to 8 pm.
6.243	HIIN	CIUDAD TRUJILLO, DOMINICAN REPUBLIC; evenings.
6.280	HIIZ	CIUDAD, TRUJILLO, DOMINICAN REPUBLIC.
6.330	COCW	HAVANA, CUBA; midnight to 1 am.
6.345	HER4	BERN, SWITZERLAND; 9:30 to 11 pm daily except Saturday.
6.370	——	LISBON, PORTUGAL; home service, 4 to 8 pm.
6.370	WKTM	NEW YORK CITY; European beam, 6 pm to 5 am.
6.380	HIIX	CIUDAD TRUJILLO; DOMINICAN REPUBLIC.
6.405	TGQA	QUEZALTENANGO, GUATEMALA; 9 pm to 2 am.
6.440	HIIS	SANTIAGO DE LOS CABALLEROS, DOMINICAN REPUBLIC; 6 to 8 pm.
6.47	COHI	SANTA CLARA, CUBA; afternoons and evenings.
6.480	TGWB	GUATEMALA CITY, GUATEMALA; 7 am to 8:10 pm daily except Sunday.
6.715	ZLT7	WELLINGTON, NEW ZEALAND; daily at 5:30 or 6 am.
7.000	WGEA	SCHENECTADY, N. Y.; Brazilian beam, 8:30 to 11:30 pm.
7.014	CMZI	HAVANA, CUBA; 11 pm to 12:10 am.
7.020	——	PONTA DELGADA, AZORES; heard Sundays 4 to 5 pm.
7.065	GRS	LONDON, ENGLAND
7.12	GRM	LONDON, ENGLAND; 8:15 pm to 4 am.
7.180	——	"STATION DEBUNK"; 8:30 to 9 pm.
7.185	GRK	LONDON, ENGLAND
7.210	——	BERN, SWITZERLAND; heard at 9:30 pm.
7.230	GSW	LONDON, ENGLAND; North American beam, 10:15 to 11:30 pm.
7.230	——	ROME, ITALY; off since September 8th, 1943.
7.230	KWID	SAN FRANCISCO, CALIF.; Oriental beam, 6:30 am to 12:45 pm.
7.24	DXJ	BERLIN, GERMANY; 9 pm to 1:30 am; 11 to 11:30 am.
7.250	KGEI	SAN FRANCISCO, CALIF.; N.E.I.-Oriental beam, 1 am to 1:05 pm.
7.260	GSU	LONDON, ENGLAND; North American beam, 5:15 to midnight.
7.290	DJX	BERLIN, GERMANY; variable times; North American beam.
7.295	YSO	SAN SALVADOR, EL SALVADOR; "Voice of Democracy"; nightly at 7:55 pm.
7.31	2RO19	ROME, ITALY; off since September 8th, 1943.

(Continued on page 312)

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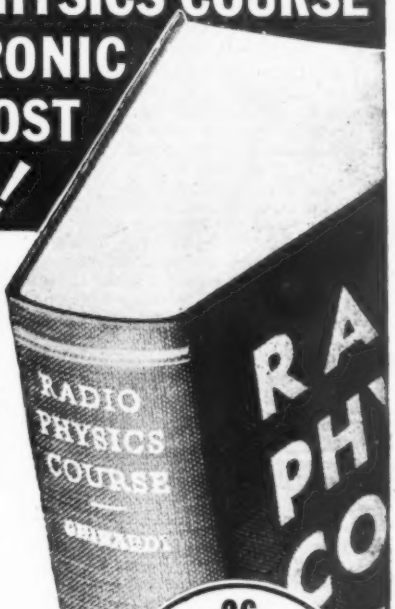

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100 amperes, 600 volts; *Giant* Size— for handling fuses 100 to 600 amperes, 250 volts; and 60 to 400 amperes, 600 volts; *Jumbo* Size—for handling fuses 200 to 800 amperes, 250 volts and 200 to 600 amperes, 600 volts.—*Radio-Craft*

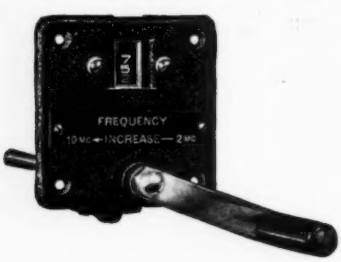
COIL COUNTER ASSEMBLY

Barker & Williamson
Upper Darby, Penna.

DESIGNED for registering rotary coil turns, the Cyclometer Type Counter Unit has many additional uses and is now being produced as a separate item. It is adaptable to practically any application where a shaft must be turned a predetermined number of times, or set at any predetermined position. The exact number of turns, down to tenths of a turn, are recorded on the counter.

Used with Rotary Coils, the Counters provide a quick, easy means of setting the contacts at any desired inductance value. Other uses range all the way from recording vertical and horizontal stabilizer adjustments on airplanes to practically any job where a shaft must be rotated more than 360°, and the exact rotation recorded.

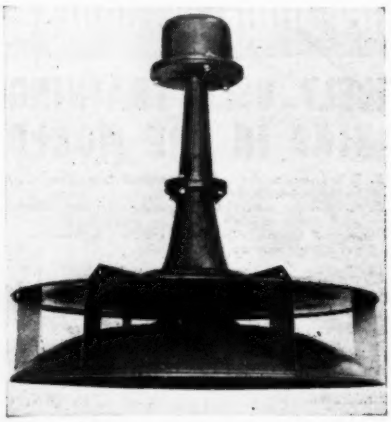
The counter assemblies have direct shaft drive (1:1 drive shaft to driven unit.) Shafts can be any length. A Veeder-Root counter is used. The gear drive is direct, with precision cut steel gears. Units are light in weight (8 oz.), extremely sturdy, and pass war-time specifications. They are available with either right or left hand rotation, and can be supplied with name plates to suit the application.—*Radio-Craft*



ANNULAR SOUND DISTRIBUTOR

The Langevin Co., Inc.,
New York City

THIS distributor utilizes a different principle of sound distribution in that it combines molecular reflection and collision instead of collision alone as in other speak-



ers. The use of this principle is said to result in a uniformity of sound distribution both as to frequency and power over a horizontal plane of 360 degrees and a vertical plane of approximately 40 degrees. The Type L-360 Distributor is 23" in diameter with an over-all height of 25". It will safely handle power input of 20 watts when equipped with Jensen U-20 Drive Unit. —*Radio-Craft*

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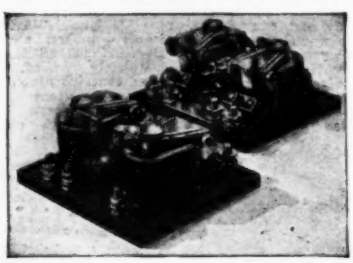


mechanisms are thus provided for a wide range of aircraft and other applications. These include the operation of retractable landing gears, wing flaps, trim tabs, bomb bay doors, hoists, and similar applications utilizing reversing motors. For winch operations, the relays permit the substitution of a simple locking dog for the conventional large magnetic brake.

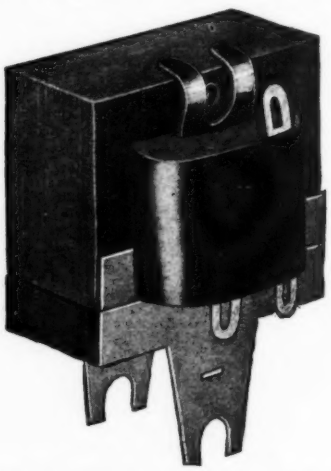
There are no sliding contacts. Positive "memory" contacts select the proper field winding to give reverse torque for braking. All parts and contacts are readily accessible for inspection. The relays operate in all positions, and withstand salt-spray, vibration and altitude test.—*Radio-Craft*

FIXED AIR-GAP CHOKE

Industrial Electronics Corp.
Newark, N. J.

A GAP which will not change its size during a long life, or at widely varying temperatures, is claimed in this line of small chokes. The gap is fixed by using a spacer of nichrome or other alloy wire which has practically a zero temperature coefficient. Fibre or other types of spacers used in the past have been abandoned. Brass braces are used to keep the laminations from expanding, while the alloy wire prevents them from contracting beyond their setting point.

At present these chokes are used solely in fluorescent lamp starters. There is little doubt that they have a field in radio and electronics, wherever—especially in such

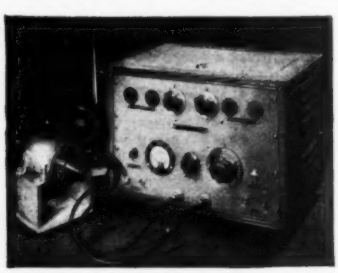


applications as swinging chokes and impedances in audio filter systems—chokes which will maintain an exact inductance are required.—*Radio-Craft*

ELECTRONIC FLAW DETECTOR

General Electric Co.
Schenectady, N. Y.

A NEW, high-frequency, electronic flaw detector for production-line detection of longitudinal cracks and seams in nonmagnetic metallic tubing is capable of detecting and locating imperfections ½ in. long, 10 mils wide, and one-third of the wall thickness in depth, even though they are on the inside of the tubing and do not appear on either surface. It is especially desirable for testing tubing for coolers and heat exchangers before installation, preventing failures in the field.—*Radio-Craft*



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The Question Box

All queries should be accompanied by a fee of 25c to cover research involved. If a schematic or diagram is wanted, please send 50c, to cover circuits up to five tubes; for five to eight tube circuits, 75c; over eight tubes, $1.00.

Be sure to send the fullest possible details when asking questions. Give names and MODEL NUMBERS when referring to receivers. Include schematics of your apparatus whenever you have such. Serial numbers of radios are useless as a means of identification.

All letters must be signed and carry FULL ADDRESS. Queries will be answered by mail, and those of general interest reprinted here. Do not use postcards—postmarks often make them illegible.

No picture diagrams can be supplied. Back issues 1942, 25c each; 1941, 30c each; 1940, 35c each. Any issue, prior to 1940, if in stock, 50c per copy.

A UNIVERSAL TUBE CHECKER

? *Please print a diagram of a tube tester that will check all types of modern tubes. —Several Readers.*

A. Because of the switching arrangement of the tube tester in the diagram, it will check all types of tubes, no matter what terminals are brought out where. Five sockets only are shown, for convenience in the diagram, but others may be added for midget-type, loktal, European and other tubes, paralleling the connections with those of the standard type socket of the same number of terminals already in the schematic.

It should be noted that the connections are run on a functional basis, rather than strictly according to terminal numbers. Thus the leads which are more commonly run to filaments are the same throughout, even though this means connecting up terminals 1 and 4 on the 4-prong socket to 2 and 7 on the octal. By the same token, these same leads should be extended to terminals 1 and 8 of a loktal socket.

The advantage of this method is that several of the switches can be left in position for most tests; the disadvantage is that a schematic of the set is necessary every time a new type of tube is to be checked. The constructor may prefer to parallel each terminal of the same number in all the sockets, for easier reference. A secondary advantage is that the regular filament leads can be made of much heavier wire than the others, to carry the filament currents.

In checking a tube, filament voltage is adjusted to the proper value with the switch on the transformer secondary. The filament leads are connected across the winding, switched to the two top bus-bars shown as heavy lines in the drawing. Cathodes and shields are connected to the bottom filament bus-bar. All other elements are connected to the high-voltage bus of about 30 volts, (the heavy black line at bottom of drawing). To check for shorts, flick each switch (with the exception of filaments), connecting each element alternately to high-voltage and negative. The neon light will glow when any element shorted to one of the others is connected to the opposite bar from the one to which it is shorted. When all elements have been tested for shorts, throw switch SW, which should be of the instantaneous type, remaining in the "short" position except when held down manually. The switch which shunts the 25-ohm resistor across the meter should be of the same type, necessitating holding down two switches when testing most tubes. For heavy-current tubes, rectifiers, etc., this shunt remains across the meter.

The checker is calibrated by testing a number of known good tubes and noting the reading.

Provision is made for free-point tests, by inserting pin jacks, and for an analyzer cable. These may be omitted if not required.

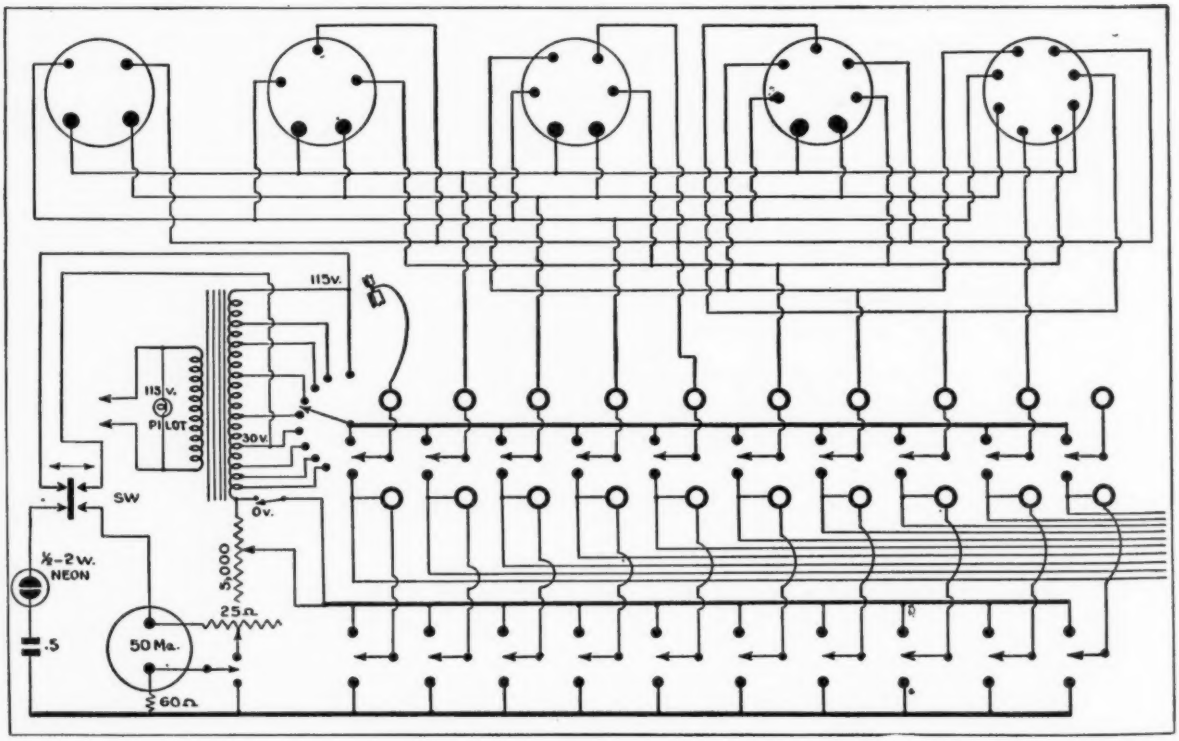
●

ABOUT THE KANGAROO

Dear Editor:

Sorry, but I must take exception to some of the statements made in the article on the "Kangaroo" inverter which appeared on page 742 of the September 1943 issue of *Radio-Craft.*

(Continued on page 294)



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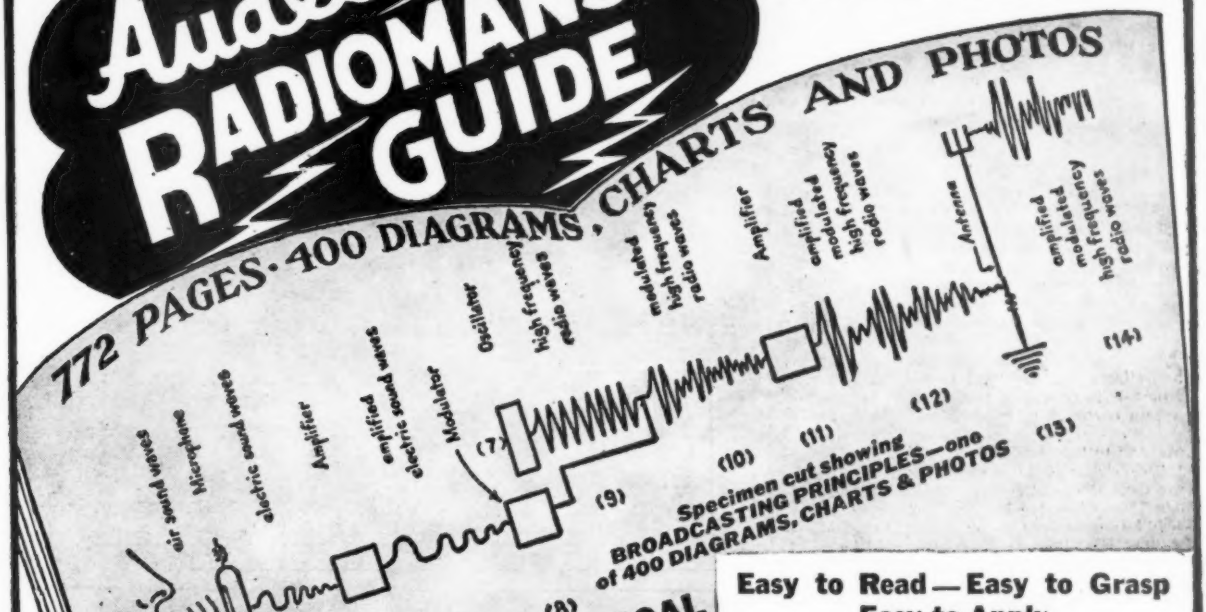

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1. You speak of Tube No. 1 as an "inverter tube." Actually, it is not, though the diagram as a whole is an inverter circuit. The function of an inverter tube is *not to amplify*, but to take part of the A.F. voltage applied to the first P.P. grid and *invert the phase* 180° for the second P.P. grid. In your circuit Tube No. 1 is used to amplify and not to change the phase of a voltage. The 180° out of phase voltages are obtained, not through the action of this tube, but rather because of the way the output is divided across two load resistors.

2. Referring to Tube No. 1 again, you state that it "adds nothing to the signal, merely splitting it . . ." Not so, sir! The output is very much greater than the input, for here you have normal amplifier action and there is nothing to prevent you from giving your total load resistance and the applied plate voltage optimum values.

$$\text{Gain} = \text{Mu}\,\frac{R_L}{R_L + R_P}$$

True, your output is split into two parts, and, therefore, the gain is *half* as great. But a gain of, let us say, 60 then becomes a gain of 30. A gain of about 3,000% cannot be referred to as adding "practically nothing to the signal."

3. The output is not merely split "so that the two grids of the next stage will receive equal impulses." The word "merely" as used here conveys the idea that it is the *only* reason. If that were so, there would be no need of splitting the voltage output, all you would have to do would be to tie the P.P. grids together. Of course, you, and most of your readers—but not all of them—know that a 180° phase displacement is just as important as equal voltages for proper P.P. action. It should have been mentioned with the "equal impulses" explanation for splitting the output voltage.

LT. B. FAUST,
Dodge City, Kansas

(We are not prepared to agree that the "kangaroo" is not an inverter. The inversion which takes place in the associated circuits takes place because of a characteristic of the vacuum tube—that an increase of voltage on the grid causes an increase of current between the cathode and plate. Without this effect of the tube, the network of resistances would become a simple in-phase voltage divider.

Incidentally, there was a mistake in that diagram, which may have caused part of the misunderstanding. To bring the input return to the junction of the 10,000 and 100,000-ohm cathode resistors would in most cases short the 100,000-ohm unit, to A.C. if not both A.C. and D.C. The return should be to ground.

Referring to the drawing—bottom corner, the September Question Box—we have two 100,000-ohm resistors, one connected to the plate and the other to the cathode (as far as audio frequencies are concerned). Again for audio frequencies, the other ends of these two resistors are connected to ground, either directly or through large condensers.

Let us call the point where the plate resistor connects to the plate, A; and that where the cathode resistor and cathode meet, B. The other ends of both these resistors are grounded to A.C. of audio frequency.

If a signal makes the grid positive, the cathode-plate current increases, and an increased current accordingly flows through them both. The current is the same through both resistors, and consequently the voltage drop through both will be the same. These voltages appear as a relative *decrease* of the voltage between point A and ground, and an equal *increase* between B and ground, The voltages produced by the action of the tube across these two points are 180 out of phase, like the voltages across the secondary of an input transformer with its center tap grounded.

The output stage grids are connected through the condensers to points A and B, and therefore are excited exactly as if they were attached to the ends of a transformer secondary.

Obviously, the tube and the two resistors, as well as the grid resistors of the output stage, combine to produce the inversion.

As to your second point. The statement was made as a result of actual experience with a number of these and other types of inverters, without considering *why* there was little or no amplification. A study of the circuit shows the reason. As the grid voltage is increased, so is the current through the cathode resistor. This brings the cathode voltage up and reduces the actual voltage between the grid and cathode. The cathode voltage follows that of the grid. It is well known that degenerative effects may be produced with a cathode resistor of only a few hundred ohms. If you apply your gain formulas, taking the negative amplification effect of the degenerative feedback into consideration, the results will be altogether different.

Once what is left of the signal is safely in the plate circuit, it is cut in two again. What little voltage there is must be divided across the two resistors, giving only half as much voltage to the succeeding grids as would be available in a straight amplifier circuit.

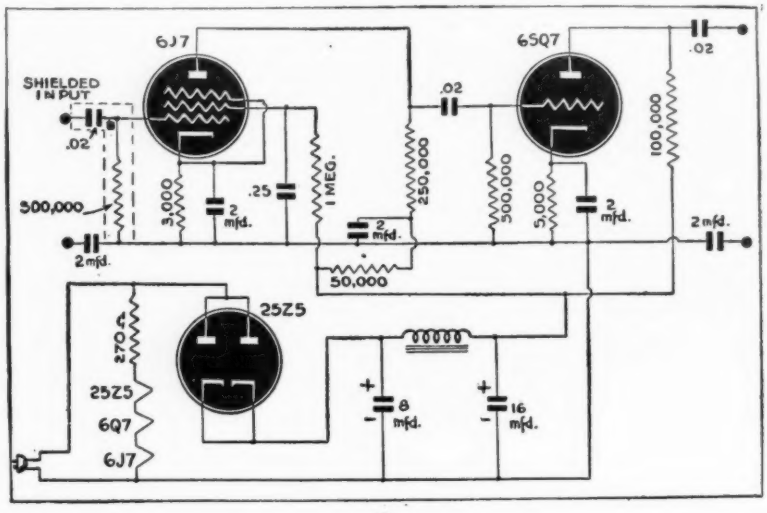
So if you hook up one of these, don't be surprised if the gain approaches zero, or even appears as a negative figure. You can figure it out exactly beforehand.

As to the splitting so that the two grids will receive equal impulses. Thanks for the correction. The average serviceman would take it for granted that the main object in an inverter tube is to obtain out-of-phase voltage on the push-pull grids, and would accept that "merely splitting" as "merely" another way of saying that there would be no amplification. The trainee might get an entirely different view of the same remark, as I now plainly see.—*Question Box Editor.)*

TWO-TUBE PRE-AMPLIFIER

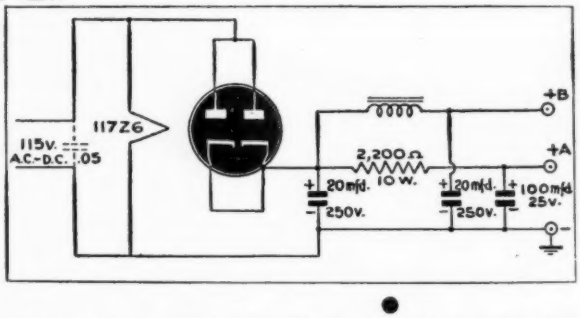
? *Will you please print a diagram of a two- or three-tube pre-amplifier, using some of the following tubes? (list given). This amplifier should be self-powered.—R.R.Y., Oakland, Calif.*

A. The tubes shown in the accompanying diagram will make the most suitable pre-amplifier. Used with a low-input mike, this will bring signals up sufficiently to input to a medium-sensitivity amplifier, or used from a phonograph, it will give sufficient gain to make possible the use of a single output stage (of a receiver for example).



POWER SUPPLY FOR PORTABLE

? *Will you please give me a hookup for a power supply for a small portable set, using a 117Z6 tube? The filament can all be connected in series, as shown in a former hookup of yours which used a 25Z5.—M.D., Dallas, Texas.*



A. The schematic is printed herewith. By using a suitable line-cord or other resistor, it can readily be adapted to almost any type of A.C.-D.C., rectifier tube. The radio on which it is used must be a type with all filaments connected in series and drawing .05 ampere per tube.

SURE, that Saturday night pay envelope's bulging. But let me tell you something, brother, before you spend a dime . . . *That money's mine too!*

I can take it. The mess out here. And missing my wife and kid.

What I *can't* take is you making it tougher for me. Or my widow, if that's how it goes. And brother, it *will* make it tough—if you splurge one dime tonight. You're making money. More money than there's stuff to buy. Money that can sock the cost of living to kingdom come—if you blow it! So hang on, till the job's done. On to every last dime—till the squeal means a hole in the seat of your pants!

You're working . . . and *I'm fighting* . . . for the same thing. But *you* could lose it for both of us—without thinking. A guy like you could start bidding me right out of the picture tonight. And my wife and kid. There not being as much as everybody'd like to buy—and you having the green stuff. But remember this, brother—everything you buy helps to send prices kiting. Up. UP. AND UP. Till that fat pay envelope can't buy you a square meal.

Stop spending. For yourself. *Your* kids. And mine. That, brother, is sense. Not sacrifice.

Know what I'd do with that dough . . . if I'd the luck to have it?

I'd buy War Bonds—and, God, would *I* hang on to them! (Bonds buy guns—and give you four bucks for your three!) . . . I'd pay back that insurance loan from when Mollie had the baby . . . I'd pony up for taxes cheerfully (knowing they're the cheapest way to pay for this war) . . . I'd sock some in the savings bank, while I could . . . I'd lift a load off my mind with more life insurance.

And I wouldn't buy a shoelace till I'd looked myself square in the eye and knew I couldn't do without. (You get to knowin'—out here—what you can do without.)

I wouldn't try to profit from this war—and I wouldn't ask more for anything I had to sell—seeing we're all in this together.

I've got your future in my rifle hand, brother. But you've got both of ours, in the inside of that stuffed-up envelope. You and all the other guys that are lookin' at the Main Street shops tonight.

Squeeze that money, brother. It's got blood on it!

Use it up . . . wear it out, make it do...or do without

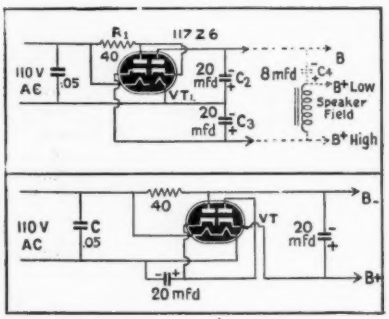
HELP US KEEP PRICES DOWN

A United States war message prepared by the War Advertising Council; approved by the Office of War Information; and contributed by the Magazine Publishers of America

Radio-Electronic Circuits

INEXPENSIVE B SUPPLY

Many users need more than the 95 to 115 volts available from a half-wave A.C. rectifier operating from the 110-volt supply. I have found the voltage doubler circuits to be the answer to many of these problems. In some cases in small receivers where the high voltage winding on the power transformer was burned out and a replacement was not available, I have been able to substitute a voltage doubler. It is



inexpensive to build and easy to construct. There are full-wave and half-wave circuits for the voltage doublers.

In the full-wave circuit shown in Fig. 1 the voltage across the load is the sum of the D.C. output voltage of the conducting diode and the condenser discharge voltage. While No. 1 diode is rectifying and charging C_1, the condenser C_2 discharges through the load. On the next half cycle C_1 discharges and C_2 charges, etc. If the resistance of the load is not too small, both condensers become charged to almost the peak supply voltage E and since they are connected in series as shown, their total voltage applied to the load is 2E approximately. It can be seen from the circuit shown that one side of the D.C. load cannot be connected to ground or to one side of the A.C. line.

This circuit may cause hum because of the high A.C. voltage between the cathodes and heaters in A.C. sets in which tubes are connected in series across the line. Very little trouble of this kind has been encountered except in power output tubes in which the cathode runs very hot. Apparently the excess heat causes the insulation between the heater and cathode to break down.

The half-wave circuit shown in Fig. 2 has one side of the A.C. line as common with the negative side of the D.C. load. In this circuit, one diode of the tube charges a condenser which in the next half-cycle discharges in series with the line voltage through the other diode of the tube.

The full-wave doubler ripple is double the line frequency, and hence is easily filtered. If a 117Z6 tube is used no filament dropping resistor is needed. Any full-wave double-cathode rectifier may of course be used with the proper filament resistor. Consult a standard tube manual, and do not exceed the rated D.C. current drain of the tube, also shown by the manual. A quick check of the rated plate currents of the tubes in the set will give a work estimate.

The value of the resistor R_1 is not critical and need be only large enough to limit the peak plate current in some applications. Care should be taken to pick out good condensers.

JOHN B. PARCHMAN,
Emporium, Penna.

●

ELECTRONIC MIXER

The following is a diagram for a three tube electronic mixer which I used with my recording amplifier. I obtained most of the parts from my junk box. It is very useful in recording dialogue from dramatic purposes.

The unit provides two microphone and one phone input. Low-level mike signals are amplified through the two pre-amplifier tubes, which are 6C6's, but may be any other tubes of the same characteristics. The mixer-fader applies either phono or mike to the second section of the 79 tube, or may be used to fade one phonograph in and the other out.

ALBAN HATZELL,
Vincennes, Ind.

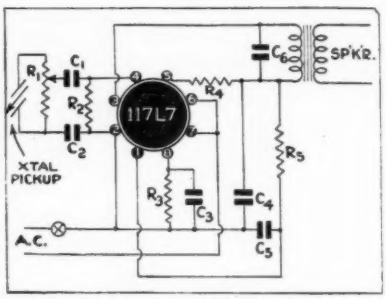
1-TUBE AMPLIFIER

Below is a single tube amplifier. It gives plenty of volume and makes a truly portable phonograph when combined with a light motor in a carrying case.

The cost of construction is extremely low with no worries of material priorities:

R1—.5 meg. vol. control, R2—.5 meg., R3—150 ohms, R4—2000 ohms, R5—100 ohms, C1—.02 mfd., C2—.02 mfd., C3—.25 mfd., C4—40 mfd., C5—40 mfd., C6—.006 mfd.

P. M. HONSINGER,
Molton, Ont., Canada



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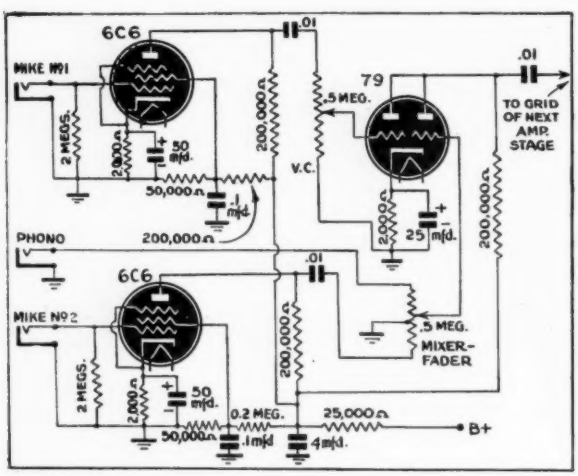
PHONO OSCILLATOR

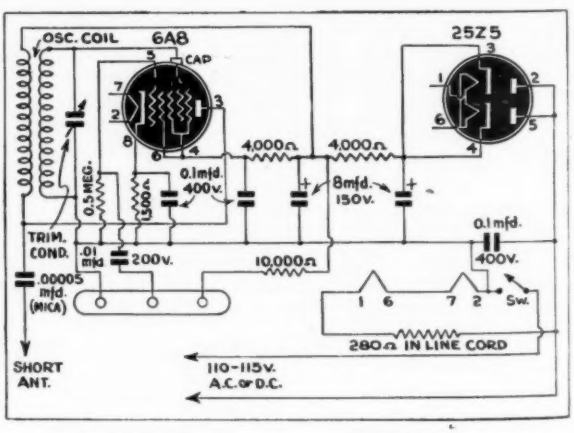
In the diagram below the oscillator will broadcast a modulated radio wave from its antenna to your standard receiver.

The two-tube oscillator uses a 25Z5 and 6A8 operating directly from the 115-V line A.C. or D.C. The signal will fall between 550 Kc. and 700 Kc. on your standard radio. Adjust the condenser on the oscillator coil of your two-tube oscillator till the signal produced by the oscillator is heard on your radio receiver.

For microphone operation, connect a jumper between the middle and right-hand terminal of the input strip. Connect the microphone to the middle and left-hand terminal. A high resistance type carbon microphone is required. For phonograph, use the same as for microphone except remove the jumper.

JOHN C. ARD,
Pensacola, Fla.





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1943-1944

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NEW YORK, N.Y.

PARTIAL CONTENTS RADIO-ELECTRONIC REFERENCE ANNUAL

ELECTRONIC THEORY AND GENERAL PRACTICE

is thoroughly covered in this book in easy-to-grasp language. Among the articles on this subject are: **What You Should Know About Electronics—Electronic Tubes for Servicemen—The Electronic Solovox**, its theory and action—and **The Photoelectric Phonograph Pickup**, the principles underlying its operation.

ELECTRONIC DEVICES YOU CAN BUILD

Among the interesting and easily constructed devices selected are the following: **Compact Hearing Aid—Oscillaplex Automatic Key and Code Machine—Electronic Relays, Capacity and Light Operated, High Frequency Radiotherapy**, a complete home apparatus—and many other timely types of electronic apparatus.

RADIO CONSTRUCTION

Many well-illustrated, how to-do-it articles, such as: **Phono Oscillators**, several types, adapted to playing records through your radio with a simple record player—**T.R.F. Sets—Superheterodynes—Power Packs for Portable Receivers**, making it possible to use your battery portable on the electric light line—**A two-tube Super Midget Amplifier**, which is a palm-of-the-hand public address system—and many others.

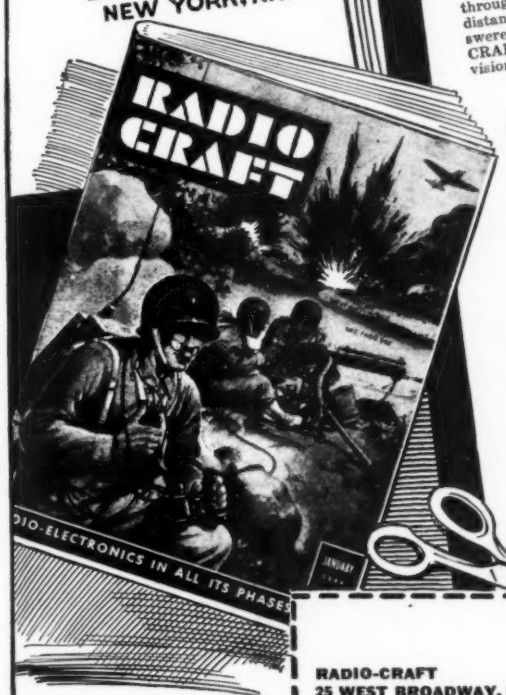
SOUND AND RECORDING, including detailed instructions on constructing: **High-Fidelity Amplifier—Exponential Horn** with perfect reproduction down to 50 cycles—**Electronic Expander-Compressor**—Also the **Robeson Technique—Semi-Pro Recording—Electronic Bass**—and **Treble-Expanding Circuits—Equalizers**, etc.

TEST INSTRUMENTS

A complete line including: **A Tube Checker** with universal hookup; can check any tube regardless of the prong to which its elements are brought out—Compact **Multitester**; 18 ranges of voltage, current and resistance on an 11-point, 2-gang switch—**A Three Tube Signal Tracer**, capable of checking R.F., I.F., and audio circuits—**A Condenser Analyzer** which measures both capacity and check leakage—and an **Electron-Ray Voltmeter** which dispenses with hard-to-get milliammeters, using a 6E5 tube instead.

SERVICING

Articles on servicing supply a multitude of methods and useful ideas, including: **Dynamic Testing with Signal Generator—Modernizing a Test Set—Calibrated UHF Oscillator**—And countless other hints for ironing out kinks in your servicing problems.



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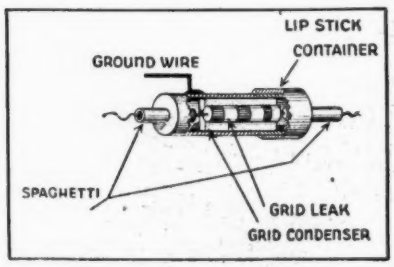
TRY THIS ONE!

LEAK-CONDENSER

This Kink will often cure that obstinate hum encountered on many A.C. short-wave regenerative detectors:

A metal lipstick container was used as a shield over the grid leak and condenser. The one used was ½ inch diameter by 1½ inches long. The lid or cover was slipped over one end, and a hole drilled in each end so that a piece of spaghetti was a snug fit in the hole. The grid leak and condenser were placed side by side and their wires twisted together and soldered.



These were then wrapped with a turn of insulating tape, the twisted wires slipped through the spaghetti, and then placed in the container. The end cover was then put on and the unit is ready to use. The case is grounded by soldering a wire to the case and the cathode.

C. W. Battels,
Akron, Ohio

●

MULTI-ANTENNA SYSTEM

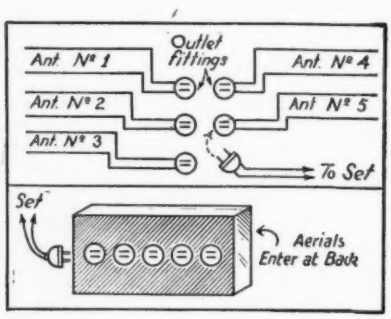
As an ardent short-wave and DX fan, I need an elaborate antenna system for best results. Switching is a problem, and because "jack" is scarce, I used a little skull drudgery to work up this inexpensive "plug" system.

Five outlets were purchased and set up as in the diagram. The doublet lead to the set was equipped with an ordinary electric light plug. (No worry about losses on the low-voltage lead-in circuit.) One antenna was attached to each outlet.

All I have to do to change from one aerial to another is to shift the plug.

It is a good idea to hook up one or two outlets as spares. The receptacles should be mounted in a box, for neat appearance and quick and easy changing.

Biagio Trimboli,
Brooklyn, N. Y.



OCTAL TUBE PRONG RIVETS

While the lowly tube base has been put to a thousand and one uses the one-thousand-and-second novel use is in the repair of old volume controls and the A.C. power switch on volume control power switch combinations.

The article, "How to Service Volume Controls," by J. Beever in the May, 1943, issue of *Radio-Craft* is excellent and "hits the nail on the head." But before cleaning the carbon element and contacting ring with carbon tetrachloride the unit must be taken apart. Since some of the old units are riveted together the rivets must be removed by either filing off the head, grinding it off with a handy grinder or by drilling it out. These methods all shorten the rivets so that they cannot be used again in assembling the unit. Due to shortages of critical materials these rivets are not available and nails, wire, brass rods, etc., are likely to be used. These are all too hard and if used, usually result in a cracked case.

The metal prongs from a discarded Octal base tube are exactly the right size and malleability for this type work. The tube base is placed in the vise which is opened enough to allow prongs to protrude down into the vise and the bottom of base is cracked with a tack hammer. This allows the prongs to be removed easily. It is not necessary to remove the solder and wire in the tube prong. The prong end is then filed off to the shoulder, which serves as the rivet head. The volume control unit can now be assembled and the prepared prong rivet inserted and filed off until it is the proper length (protruding slightly over 1/16 of an inch). The rivet is then easily flattened out with a small ball pein hammer or suitable punch. The tube prong rivet makes a neat permanent repair and the danger of a cracked volume control case is eliminated.

In the combination volume control and power switch the A.C. power switch frequently goes bad. Since this unit is usually in a plastic case which is riveted to a metal back plate it is difficult to take apart and repair unless suitable rivets are available. The tube prong rivets made as described from a discarded old Octal base tube are exactly the ticket for this, and assembly can be made without danger of cracking the plastic switch case.

By the way, the trouble with these power switches when they go bad is usually due to a weakening of the coil spring and resultant failure of the bakelite ring lever to make complete contact. Remove the coil spring and stretch it until, on release, it is about ⅜" longer than it was when removed. It will now be stiff enough to do its job. The contact points may have to be dressed with a fine file and cleaned up before assembly. Contacts may also have to be bent slight to make perfect contact. Before riveting on back plate, check with continuity tester to see that switch works properly.

R. S. Havenhill,
Josephtown, Penna.

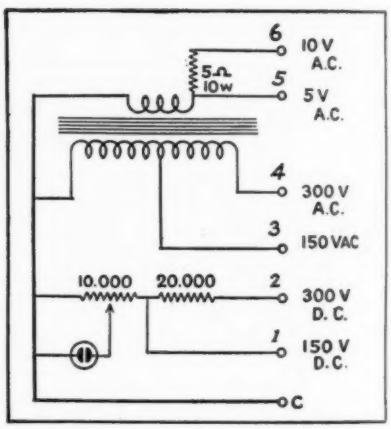
(The humble octal tube base can be used in many other ways as well. Almost every radioman has used one of them as a multi-contact plug, and the Kinks' page recently showed them as multi-pole, multi-throw switches.—*Editor*)

NEON TESTER

The little voltage tester offered here is made from odds and ends available to most experimenters and is very useful if care is used in calibrating it. When standard test equipment is unobtainable, it may help some radio-minded person to service radios.

The indicator is a ¼-watt neon bulb connected to a potentiometer so that the voltage can be adjusted till the bulb just "strikes." This striking voltage is very constant; though it is different on A.C. and D.C. and calibration curves must be run for each, using known voltages. The tester has an A.C. range from 1 volt to 300, and a D.C. range from 75 to 300 volts. The ranges can be extended higher by the addition of a couple of resistors if the constructor so desires.

The main feature of the set is the transformer, which is an ordinary push-pull output type. Other parts needed are a 10,000-ohm wire-wound potentiometer, the neon bulb, several resistors for multipliers, several tip jacks, a pair of test leads and a jumper with phone tips on each end, and dial plate and knob. The knob should have a long arm, as several scales must be drawn beneath it on the dial plate.



The method of using the tester is simple. For A.C. volts from 1 to 5, plug the leads in between C and 5 and jumper between 2 and 4. To measure to 10 volts and over connect the leads between C and 6 and leave the jumper between 2 and 4. With most bulbs 25 volts will strike with leads between C and 3 and jumper between 4 and 2. From 100 to 150 volts leads are in C and 3 and jumper between 2 and 4. From 150 to 300 volts, leads in C and 4 and jumper between 1 and 3.

D.C. voltages are measured between C and 1 or 2. The jumper is not used.

The indication point is found by adjusting the potentiometer till the bulb just begins to glow.

In extending the lower ranges we made our resistors from nichrome wire. The higher A.C. ranges may also be obtained, but the multiplying resistor must be found by cut-and-try, as it depends on the characteristics of the output transformer used.

E. C. Stockman,
Hartell, Alberta

POST WAR RADIO ANGLES

(Continued from page 265)

In ELECTRONIC TUBES for radio sets, and allied sets such as television, etc., a new crop of more efficient tubes will completely change the aspect of our receivers, and is certain to revolutionize our previous conceptions of a radio set. There are many new tubes now used for special war purposes, which have not been used in radio sets in the pre-Pearl Harbor period. These tubes are ready for the market as soon as the war is over.

CATHODE-RAY TUBES will also come to the front in an astonishing variety. This versatile and most important tube will be used for many purposes, which we never dreamt of before. Due to mass production cathode-ray tubes now can be manufactured at a fraction of their former cost. It is certain that there will hardly be a radio receiver or a servicing instrument, as well as other specialized radio appliances, in which cathode-ray tubes will not be used. There are many new uses for these versatile tubes that will astonish the public once they are introduced *en masse*.

MULTIPLIER TUBES, a pre-war development, will certainly make their appearance in radio sets, television sets, FM sets and in other radio appliances soon after the war. These remarkable devices which are in many ways even more important than cathode-ray tubes, will be one of the great surprises a few years after peace has been concluded.

Most of the radio components of the pre-war period are due for drastic changes. Condensers, whether fixed or variable, inductances, and even resistors have all undergone tremendous physical changes, not only in size but in scope as well. Many of these changes will amaze technicians and servicemen alike.

At the present time surveys indicate that there are about *fifty-five million radio sets in the United States*. Most of these receivers will be hopelessly obsolete by the end of the war. They will all have to be replaced because with the new technical advances. No one will be satisfied with a pre-Pearl Harbor radio set once the new models are going out in profusion, as they will when peace has been declared.

It is safe to predict that for many years to come after the war, radio manufacturers will be mass producing radio sets as in the decade following the middle 20s. The trend is certain to last for at least a decade or more, for the simple reason that not only will the present fifty-five million radio sets have to be replaced—but there will be a demand for twenty-five million more. *This means some eighty million radio sets must be manufactured.* That is a large order, which will take many years to accomplish.

On top of this it should not be forgotten that a goodly percentage of the post-war radio sets will be a combination of FM-AM-television. This gives a small inkling of the revolutionary changes ahead in radio.

●

Latest in "portable" electric equipment is a complete mobile central power station —of 5,000 Kw. capacity—on a railroad train of eight cars. The rolling power plant was designed by Westinghouse, and is intended for use in war areas where retreating enemies have destroyed power plants, thus disrupting civil life.

The plant is coal-operated, and is equipped with two boilers. The train carries a one-day supply of water, and condensers are provided so that this supply may be stretched over weeks if necessary.

Pincor's number one job right now is to supply fighting men with fighting tools. Our plant is on an all out war production schedule but our service department is pledged to make your present Pincor equipment last for the duration. Bring your service problems to us—but please bring only Pincor problems; there just aren't enough hours in the day to take care of any others.

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By CARL W. MAEDJE*

RESONANCE, the key theme of the radioman, has now been applied to the humblest tube in the receiver, the dial lamp. Not that the little pilot is to be tuned in to the program received—in its case resonance is a matter of matching the natural mechanical vibration frequency of its filament with that of the supports inside the bulb.

Alterations in the tiny wire "mounts" and filament supports are said to have made the G.E. radio panel lamp virtually immune to physical shock.

Formerly, a violent bump as from dropping a radio panel lamp on the floor or violent vibrations picked up from the loud speaker, would sometimes break the filament or filament connection.

To determine the behavior of the inner construction of the little lamps under stress and to arrive at the best construction, led to considerable research . . . even to the building of a special rotary "hot-shock" testing machine.

Under violent shock or intense sympathetic vibration, the filament in the former lamp was found to take a terrific "beating." Chief trouble: the frequency of the filament was "fighting" a different frequency set up in the support construction.

Further study showed that extending the support wires to greater height and raising the height of the supporting "bead" permitted the filament to vibrate without "stretching" or "bowing."

The panel lamp, A, at the head of the article, with its stubby filament supports and "bead" positioned low, is typical of the old type of lamp. The coiled tungsten filament carried the brunt of the shock when the lamp picked up vibrations from loudspeaker or from a jolt. Above may be seen microphotos of the filament at rest and when the lamp is subjected to vibration. It will be seen that the shape of the filament is much distorted, while the supports remain practically still.

The lamp B is one of the new type. When vibrating, the filament and supports swing together, with the result that filament shape is maintained and dangerous strains avoided.

Or as Gwilym F. Prideaux, Nela Park engineer, puts it: "The new construction brings the resonant frequency of the filament coils and their mount structures together." The fundamental vibration frequency is in a direction normal to the plane passing through the leading-in wires. Both filament and "mount" in present G.E. radio panel lamps vibrate in rhythm no matter if the vibrations are set in motion by the reproduced notes of a soprano or from a severe jolt. Result: improved lamp quality.

Proving this point in the laboratory is the rotary shock tester device with its heavy metal wheel supported by two sturdy arms. Lighted radio panel lamps are made to revolve on the wheel. A motor lifts arms, wheel and lamps, then drops the assembly with a cruel shock on two steel posts. This goes on 72 times a minute for 480 minutes. The rough treatment to which the lamps are subjected is far worse than can be expected in actual use.

Yet, thanks to their improved construction—which puts the filament vibration in tune with the mount construction—the little lamps remain lighted.

*General Electric Co., Nela Park, Ohio.

A GOOD IDEA FROM BRITAIN

ONE thing we could do right now without hurting anybody is to prohibit the manufacture or sale of any kind of domestic electrical appliances that cause interference.

Practically no electrical appliances are being made now, and an immediate enactment on the lines suggested would give manufacturers plenty of time to put their houses in order. To give one example: certain electric shavers are among the worst of offenders, interference from them extending over a surprisingly large area.

The proposed regulations would ensure that, when production starts again, fresh designs or modifications of those existing would render all electric razors offered for sale innocuous, so far as radiated interference is concerned. It would be sheer folly to allow manufacture and sales to continue on the old unrestricted lines—but that, we fear, is exactly what will happen.—*Wireless World, London*

FM DISCRIMINATORS

(Continued from page 279)

low the resting value, then the I.F. will be lower and the voltage across R1 and R2 will be positive proportionally, and the grid bias on V1 will be less negative, raising the plate current and bringing the oscillator frequency back up to its resting value. The purpose of R, C1 and C2 is to act as a sharp cutoff type filter to by-pass all frequencies above about 30 c.p.s., so that modulating voltage on the grid of V1 will not be counter-balanced by the control circuit. With this control circuit indirect crystal control of the oscillator frequency is accomplished. In single frequency type transmitter-receivers, such as is used by the police nets, these type circuits are finding widespread use.

In the next article we will discuss the adjustments and maintenance procedure for the modern FM receiver.

MUSIC IN INDUSTRY

(Continued from page 268)

who listen think it. Thus, it must be made to fit the need. Many a pair of smudged hands and begrimed face is associated with a musical ear of a high order. And whenever the music is mediocre or badly planned and presented, the lights on the switchboard are set afire by complaining voices from the factory.

For this reason the quality of the speaker can never be too high. A speaker's worth is as good or as bad as is its tone fidelity. In this instance it was found that standardization could be effected in cabinet design with approximate dimensions in inches of 20 x 20 x 20, giving a total of 8,000 cubic inches. A tuned port opening at the rear augments the base and the frequency range, peaking at 85 cycles.

In all fairness, it is reasonable to assume that a working man at his bench carries with him to the plant the same high quality of musical appreciation that he carries into his home. Therefore, the best is none too good.

ELECTRONIC GUN DIRECTOR

(Continued from page 270)

and the Director considers only the smooth rate reported over a period of several seconds.

Strangely enough, this Electrical Director originated in a dream. One night in the middle of 1940, while the Low Countries were being invaded, Dr. David B. Parkinson awoke with the impression that he had been a member of an anti-aircraft with every shot. Somehow he knew that in the gun control mechanism was an electrical device somewhat like something he had been working on in Bell Telephone Laboratories. Next morning he talked to his associate, Dr. Clarence A. Lovell; neither of them knew anything about guns, ballastics or fire control, but the problem caught their fancy. Along with their other work Parkinson and Lovell studied the problem and how telephone techniques could be applied to it. A possible solution, in memorandum form, was communicated to the Navy and the Army; the Anti-Aircraft Artillery Board promptly endorsed the venture and the O.S.R.D. agreed to finance it. A week before Pearl Harbor, a model had been delivered to the Army for test.

That model had been visualized by Lovell, Parkinson and their research associates, and the design had grown in the hands of skilled instrument makers working under direct supervision. When production had been authorized by the Army, it was necessary to translate the model into designs which would fit into the Army's field requirements and which could be made by Western Electric shop facilities. Apparatus development engineers, already collaborating on the project, undertook a large amount of mechanical and electrical design looking toward smaller size, greater accessibility and ruggedness, and the solution of certain functional difficulties.

A satisfactory device of this kind requires not only good engineering design but also the application of the techniques of manufacturing necessary to produce a product which will stand up in field service. Here the long experience of the Western Electric Company in making telephone equipment for reliable performance has been applied to making these Directors dependable units in field service.

It was necessary that the Army, in adopting a new device such as this, should provide for adequate training of its people in handling the equipment. Here, the Laboratories were again able to assist the Ordnance Department by providing training for about 350 Army people. Instructors in this school have been engineers drawn from the Laboratories staff.

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SYLVANIA SERVICEMAN SERVICE

by FRANK FAX

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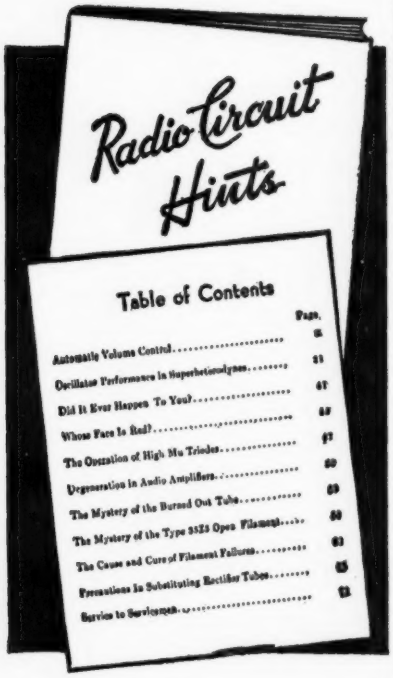
Radio Circuit Hints

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RADIO DIVISION - EMPORIUM, PA.

ELECTRONICS IN MODERN WARFARE

(Continued from page 271)

munications equipment. It automatically follows that no modern military power can hope to achieve war supremacy until it attains superiority or at least equality in the matter of electronics equipment.

The high-speed mobile nature of modern combat has necessitated the development and extensive use of the ultra-short-wave "trans-receiver" and "walkie-talkie" type of communications unit. They have been applied to the foot-soldier, the tank, the mechanized unit and the plane. Not much will be said of them here since they have been extensively covered in radio literature. However, it can be stated as a matter of course that a modern army's effectiveness while deployed in battle formation depends upon the speed and thoroughness with which military intelligence is transmitted between its various specialist units.

P. A. SYSTEMS WIDELY USED

An interesting development in military communications equipment is the naval application of commercial PA systems to warship inter-communication work. The highly technical nature of a modern battlewagon, the deadly accuracy of its fire-control equipment, the great fire-power and unbelievably destructive effects of centrally-controlled naval turret batteries and the development of intricate battle-damage control systems make vital the swift and efficient team-work of the trained specialists manning the war vessel. This of course necessitates the use of extensive communications equipment.

A few glances through a warship which has caught an enemy salvo is enough to have this fact rammed home with shocking clarity. The sight of massive armor punched through and buckled up like wet cardboard, clouds of jagged shrapnel holes ripped through flame-seared and blood-sea-water- and oil-stained bulkheads and equipment, and the tragic scene of death and destruction everywhere, point out the terrible penalty for allowing the enemy to be the first to get organized for battle and to begin to pitch strikes.

In order to get organized for combat rapidly, much of the naval intership communications is with the usual long and short-wave radio units, and various visual signalling sytems. Most of the ship internal communication is handled with sound-powered battle phone systems. Some of it is done with synchro indicator systems, simple electrical indicator circuits, telegraph lines and speaking voice tubes.

To supplement the battle-phone and other I.C. systems, PA systems have been applied to naval warcraft to increase battle efficiency. Two or three of the more recent types which have proven to be highly successful are based upon the well-known "talk-back" inter-communication type which have been used in commercial office buildings for many years. An army type high-power PA unit is now used for inter-ship communications.

In the case of aerial warfare, it is needless to add that the effectiveness of the plane as a military weapon would be seriously curtailed if it were not for the extensive use of radio communications, especially in cases where offensives are to be carried out against the enemy. Because of the great speed and range of the modern plane and the ever-present problem of fog, cloud formations, storm and night flying, the airplane would be much like a blinded and deaf animal if it were not for this development.

Says Lt. Gen. Harbord of RCA:

"Radio helps to time the attack, to locate the enemy and aid the artillery in accurately placing its shots. Radio is the voice of the commanders on the beachheads and at the bridgeheads, of troops in foxholes and of sailors in lifeboats or on rafts. Radio coordinates military and naval operations; it saves lives, time and material. The split-second precision of the mighty air squadrons flying over Berlin would be impossible without radio instructions, coordination and navigation. Radio at the same time is used to confuse the enemy, to prevent concentration of interceptor forces, and to draw enemy fighter planes to another city distant from the target. There were no such radio tactics in the First World War. Radio then was used for exchange or delivery of messages, but on a greatly limited scale compared to its modern uses."

BROADCASTERS AS WEAPONS

Not only has electronics communications equipment assumed a dominant position in actual combat but also in the war of words which the Nazis have developed to such a high degree of perfection. While the actual value of war propaganda will undoubtedly be some day found to have been overestimated and confused with internal corruption, its value as a spur and guidance to underground elements within captive countries—the "armies within"—cannot be taken lightly. As a consequence super-powered short-wave transmitters have been developed and installed in this country to such an extent that the U. S. can now be considered to be the undisputed leader in this field.

Not only short-wave transmitters but all other radio devices have been vastly im-

"Yes, I killed two birds with one stone—combined the ear-muffs with radio headphones."

proved as well under the stimulus of war necessity. Radio design and production men have learned much about radio component design from the unusual and rigid military specifications that they have had to meet. They have learned how to make highly compact, lightweight, and rugged equipment with unusual operational characteristics. A great many radically new circuit, component and tube design developments had to be worked out in order to meet the severe specification demands.

Not only unusual performance has been demanded but under almost impossible conditions as well. Ordinarily sensitive and delicate radio devices had to be designed so as to operate under violent shock and vibration stress, moisture condensation, extreme humidity, desert dryness and sand-dust, salt sea-air corrosion, jungle mold-rot, temperature extremes, violent temperature change and submersion conditions. High-tension circuits had to be constructed so as to operate satisfactorily under low barometric pressure conditions. Furthermore, with all these drastic requirements, the equipment as well as its individual sections must be readily accessible for quick battle-damage repairs.

Not only radio equipment but auxiliary test and laboratory equipment has also been improved and developed to a corresponding degree. Radical improvements have been made in cathode-ray oscilloscopes, electron microscopes, analyzers, industrial control and test devices, automatic remote control systems using electronic control, etc. One of the more unusual test units is the elaborate balanced - bridge - and - selector - switch type of analyzer with which an inexperienced operator can test out a complete radio or electronics device automatically.

Out of all this high-pressure research work, lower-priced, lighter-weight, and superior performing radio and electronics equipment will be available to the public when the war is over.

DETECTION SYSTEMS

Several types of military detection and protective systems have been either developed or improved during this war. Some of these operate upon surprisingly simple principles. Most of them are old stuff and are common knowledge among all the combatants in this war. However, because of wartime necessity, they will not be discussed here. Among such simple electrical devices are the degaussing system and mine and booby-trap detectors. These have been developed out of simple "treasure locator" circuits and have been well known for years.

These simple devices will have many peace-time applications in geology, mining, civil engineering, and perhaps possible traffic safety equipment.

As one stands before one of these marvels of design, a dawning realization of the heights of technical genius to which American research men have risen under the pressure of war necessity begins to make itself felt. The reaction is inevitably this—"How can any enemy, no matter how cunning or ruthless, ever hope to conquer a people capable of devising anything like this?"

●

Among recent FM applications filed at Washington is one from the Spartanburg (S.C.) Advertising Company which wants to place a 10,000-watt installation atop Hogback Mountain, some 20 miles from Spartanburg. A coverage of 26,000 square miles is sought, using a channel of 43.5 megacycles.

USING CAPACITORS

(Continued from page 280)

operating frequencies. Generally, it will be sufficient to specify whether the capacitors are to be operated at low or high audio frequencies or at radio frequencies. Most capacitor manufacturers will accordingly check capacitance at 60, 120, or 1000 cycles or at 1000 Kc. Several manufacturers are equipped to make such measurements at frequencies between 100 Kc. and 50 Mc.

WHAT TYPE CAPACITOR?

Circuit design, chassis layout, ambient operating temperature, stability requirements, capacitance value, mechanical requirements, and designer's preference are a few of the factors influencing the type of capacitor selected. Generally, the following rules will be followed in this choice:

Wax Impregnated Type: Employed universally where the ambient temperature is not high or too low and where close capacitance tolerance is not required. This type is generally employed in low-voltage circuits where total impressed voltage does not exceed 600 v. Available in several container sizes and in tubular and box shape. Where shielding is necessary, as in very high-frequency circuits, this type is obtainable in metal cans.

Oil-Impregnated Type: Applications identical with those of wax-impregnated

(Continued on following page)

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"I have been in the broadcasting field since graduating from National. Am with Station WIBX. I recommend your School."—Fred Hoffman, Utica, N. Y.

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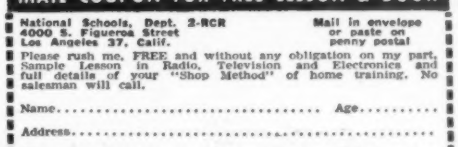

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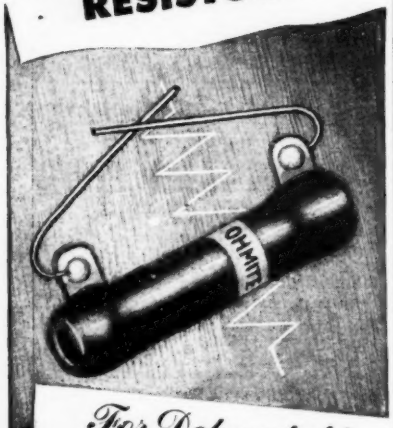

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type, except that the oil-impregnated capacitor may be employed in high-voltage circuits, where the total impressed potential is several thousand volts, and may be operated at higher ambient temperature levels than may the wax-impregnated type. Like the latter, the oil-impregnated capacitor is available in a number of sizes and shapes for given capacitance and voltage ratings. This type is always metal-enclosed, and may be supplied in dual and triple units.

Electrolytic: Universally employed where large capacitance values are indicated, such as in power supply filters. Not recommended for circuits in which leakage current must be low. The electrolytic type is available in cylindrical and boxed shape; in several mounting styles, including plug-in in metal-cased, paper-cased, and tubular construction; and in single and multi-section units. Except when several units are internally connected in series, electrolytic capacitors are rated for D.C. working voltages up to 600 v.

Mica: Mica capacitors are employed in the most exacting electronic applications. Their exceptional stability recommends them for use in high-frequency tuned circuits and in similar positions where close capacitance tolerance, capacitance stability during operating life, and minimum losses are important. These units afford stable circuit operation under some of the most adverse conditions of operating temperature, humidity, and electrical and mechanical abuse.

For the most critical applications, the silvered type of mica capacitor is recommended. For all other uses, the stacked foil type will be found satisfactory. Small bakelite-molded mica capacitors are supplied in capacitances up to 0.01 mfd. and are rated to withstand operation voltages of 500 D.C. Larger-size molded and potted units are available at capacitances up to 0.5 mfd. and are rated to withstand several thousand volts D.C. Large capacitances and extremely high voltages are available from most manufacturers on special order.

Q AND POWER FACTOR

The *figure of merit*, or Q, of a capacitor is a statement of its quality (generally at radio frequencies). In radio-frequency practice, the Q value has entirely superseded the low-frequency power factor. Since Q is the ratio of a capacitor's reactance to its R.F. resistance, it expresses directly the quality of the unit.

For highest Q, mica capacitors are recommended. High Q is most desirable in radio-frequency tuned circuits and in high-frequency audio circuits where excellent selectivity is desired.

Capacitors intended for lower-frequency applications (as in audio-frequency and power circuits) are likewise frequently required to show low-loss characteristics. *Power factor* (which is a ratio of the capacitor's A.C. resistance to its impedance) is measured at 60, 120, or 1000 cycles, or at some other frequency specified by the customer. Since power factor expresses the total loss introduced by a capacitor, it is an inverse indication of the capacitor's merit at the frequency of merit. Thus, the lower the power factor percentage, the more efficient is the capacitor.

TEMPERATURE COMPENSATION

In exacting electronic circuit applications, it is imperative that the capacitance drift due to temperature reach as low a value as practicable. Where low values of capacitance-temperature coefficient are demanded, mica capacitors are indicated. The lowest temperature coefficients are possessed by silver mica capacitors.

Special types of mica capacitors are compensated for temperature and may be obtained on special order. These units are constructed for zero capacitance change or for any positive or negative capacitance change within an ample range.

INVENTORS & ELECTRONICS *(Continued from page 277)*

The radio part of this clothes or metal drier has three radio tubes, much like the ones in our radio sets. They, in this instance, enlarge the heating capacity of the apparatus instead of boosting the voice or other sounds coming through our usual radio tubes.

Just as radio waves permeate everything, concentrated radio heat penetrates the interior of a coating of paint, for example, and dries up the moisture within the coating, baking the article within a few fleeting seconds. This radio drier thus reduces the time for robbing fabrics, metals, ink and water-soaked articles of moisture from four hours to several seconds. And, furthermore, these same radio waves may be used to bring in the Philharmonic Orchestra or "Pistol Packing Mama."

ELECTRONICS IN THE HENCOOP

The hen that lays the golden eggs is no longer a figment of the story-teller's imagination, for in these days when meat shortages leave a big gap on the protein side of a blue plate, every egg is worth its weight in gold. The government's demands for a 28 per cent increase in the chickens that go to market, and a thirteen per cent increase in eggs from the hens that stay at home, are causing the poultry farmers to use as much modern equipment as a progressive nursery.

One of the most novel ways to assure that all is well down on the poultry farm is to measure the pulse rate of chickens. This procedure is not the simple thumb-and-stop-watch method used on human beings. Neither is it as modest as the stethoscope treatment of the family physician. For the heart of a chicken is far too small to have its beats detected by the ordinary stethoscope. Whereas the normal adult human being's heart pulses at a steady rate of from 70 to 75 beats per minute, a chicken's heart gallops along at about 370 beats per minute. To get an accurate record of this hammering heart required the use of a microphone, which includes a crystal stethoscope, an amplifier and a two-speed recording machine. These instruments have been combined successfully by E. W. Henderson and H. E. Hathaway, both of the Michigan Agricultural Experiment Station, into a device that is as important to poultry investigators as the little black bag was to the horse and buggy doctor.

The microphone is applied between the feathers just above the anterior portion of the breastbone of the fowl. The amplifier enlarges the sound of the beats to a degree where they can be recorded on wax records at the rate of of 78 revolutions per minute. The count is then made by playing the record at just over 33 revolutions per minute. If a permanent record is not desired the counts of the pulse beat can be made directly by the use of an electrical counter connected to the circuit.

Reminiscent of the radio-controlled aerial torpedoes now so much publicized, a small bombing plane developed by Louis M. Church, radio engineer and model plane builder of the War Department, is capable of automatically dropping explosives from an altitude of 400 feet onto an automobile. It may be the forerunner of giant bombers operated by radio, carrying incendiaries or block-buster bombs over enemy territory, eliminating the loss of skilled bombardiers and slashing the huge expense incurred by prevailing bombing expeditions.

If this 56-year-old War Department employee's new method of dropping high explosives rates as high in practical experiments as in theoretical promises, a baffling problem of Army engineers may be approaching a solution. A robot plane, actuated remotely by radio waves, is the ultimate goal of aeronautical engineers, and based on the test performances of Mr. Church's model plane the achievements possible are: (1) Carry bombs over enemy territory, drop them and return to the home base; (2) carry supplies, arms and ammunition to marooned troops, say, in the South Pacific; (3) scatter friendly literature over enemy territory, warning the masses of German or Italian people of an invasion liberating them from the Fascist yoke; (4) drop flares on hostile ground as an aid in obtaining military objectives.

These might even be used to hunt down the rocket carriers of which so much has been heard recently, and we can even think of wars in which most of the aerial dogfighting will be done by robot planes, controlled from underground bomb-proof shelters.

STILL OTHER INVENTIONS

Other electronic gadgets patented recently by inventors hopefully preparing for an all-electronic world include electronic speedometers for motor cars; electronic controls for paint-spraying machines; an automatic floating-ball radio station supposed to be dropped from an airplane forced down at sea, thereupon to go into action and broadcast the location of the accident; devices for electronic disinfection of hats and footwear in stores, and even electronic control of growing plants!

Many of these inventions are far-fetched and impractical beyond question. The old engineer will be extremely cautious in selecting the worst and the best of them, because he remembers that in the past it has been the thing that seemed almost reasonable that failed to come through, while such absurdities as, for example, human flight and talking through space, have become mighty industries.

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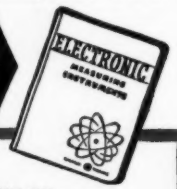

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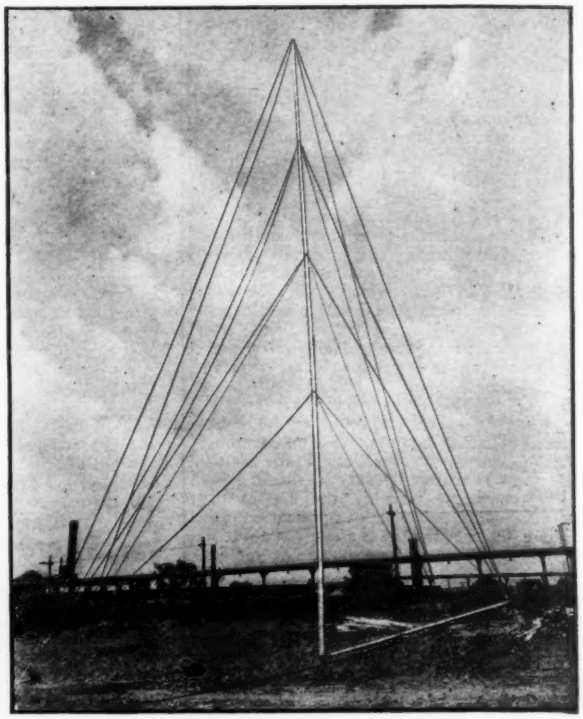
Electronic Measuring Instruments

AN IDEAL RADIO MAST

EVERY radio amateur has dreamed of a radio mast of practically unlimited height and strength, with weight approaching zero. The ultimate would be "a 60-foot mast that one man could erect alone" and which would presumably stand up through a stiff breeze.



This fantasy has just been surpassed in cold reality. A new method of using wood has produced a mast, which can be erected by one man in an hour's time, and which is not 60, but *90 feet high!* (It is not known whether hams can place orders now for priority delivery immediately after the war.)

The new masts are built by Plymold Corporation, a Massachusetts concern, and are made of plastic-cemented plywood. A special method of construction gives them great strength with a minimum of weight. They are in the form of hollow plywood tubes. Three layers of thin veneer are used. The grain on one layer runs up and down the pole, while the other two layers are so placed that their grain makes an angle of 45 degrees with the length of the mast, and of 90 degrees with each other. This "3-phase" construction gives great strength in all directions. The strength is increased by the special thermosetting plastic resins with which the layers are bonded together.

The layers of veneer are first impregnated with the plastic, then wrapped on a mandrel, where they are bonded under heat and pressure. Strength is built up by increasing the number of plies, at all times maintaining the "3-phase" orientation of the grain. Tubes with a wall thickness of one-half inch have been made, and there is no reason why heavier ones should not be built up, should there be a reason for it.

The 90-foot mast is of the telescoping type. For transportation it nests into three bundles. One of these is 12 feet long by 7½ inches in diameter, the second 12 feet by 4½ inches, and the third 1 by 1 by 3 feet. Only a pulley is required to erect it. If two men are available, it may be put up—under favorable conditions—in one-half hour. The whole mast—complete with fittings—weighs only 200 pounds.

RADIO METERS *(Continued from page 282)*

"comparison" instrument is *known* to have a sufficient *higher manufacturer's accuracy rating* than the one being checked, and when the *inaccuracies* of the "comparison" instrument *are known at every point on every range.* That is the way instruments are calibrated at the factory—but a sufficiently accurate *precision standard or secondary standard* instrument is always used for the purpose—one having an allowable error of *one-fourth* (or less) of that of the instrument under test.

Relatively few indicating instrument users possess the facilities necessary for accurate check of the calibration of their instruments. in your community it is likely that some organization has "standard" voltmeters and ammeters of precision sufficiently greater than your own that you can check the calibration of your equipment against when necessary. A fact not generally known is that arrangements can often be made with the electrical or radio departments of local schools or colleges for such a check, at little or no cost to the service man. The instructor who has charge of the school's instruments, or a student who has access to such equipment, will usually cooperate. Likewise, the signals from your local broadcast stations can easily be utilized to check the calibration of signal generators, etc.

It is well to remember that because of the magnetic shunting effect caused on the field of the permanent magnet, the reading of a D.C. instrument will usually *decrease* when the instrument is mounted on a steel panel. The amount of decrease depends upon the particular instrument and the thickness of the panel. If the instrument is to be used in a steel panel it is well to check the accuracy while it is mounted on it.

Do Not Check Instruments by Making Tests on a Radio Set

Another instrument checking method which leads service men to incorrect conclusions is that of checking the accuracy of their test instruments by making voltage-current-resistance tube-socket analysis on

new, standard receivers just arrived from the factory. They compare the readings obtained with their test instruments against the values specified for those particular quantities on the voltage-current-resistance charts supplied by the receiver manufacturers. See Fig. 3. There are several reasons why this practice leads to incorrect conclusions:

1. The line voltage may not be of the exact value specified for the receiver.
2. Voltage, current and resistance check-values supplied by receiver manufacturers for their sets are always specified with the understanding that a tolerance of *at least plus or minus* 10% should be allowed. Often, the allowable tolerance is as much as *plus or minus 20%!* How can such values be called standards by which to check an instrument having a rated accuracy of *2%?*
3. When checking the voltage values, the instrument readings may not correspond with the values specified by the manufacturer simply because the resistance of the voltmeter range used by the service man is not the same as that which was used by the manufacturer when he made the initial test. The service man's voltmeter may load the circuit more (or less) than did the manufacturer's voltmeter—thereby changing both the current of the circuit and the voltage readings.

ELECTRON COUNTER

(Continued from page 276)

type 60, counter). The variable resistances in the circuit assist in adjusting both the thyratrons and the counter input.

The second thyratron receives its impetus from the first in such a way that the tubes alternately glow at each discharge making the counter register *every other* alpha particle entering the chamber. Details of battery supplies, filament transformer, ammeters and condenser follow from the circuit diagram given. This unit is not shielded or grounded like the other two components but should be separated from them by a suitable distance on either side.

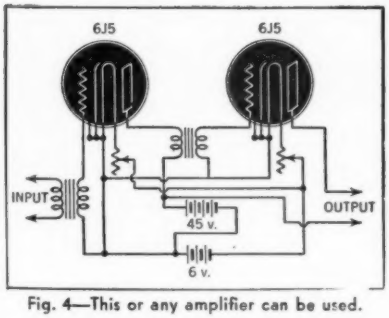


Fig. 4—This or any amplifier can be used.

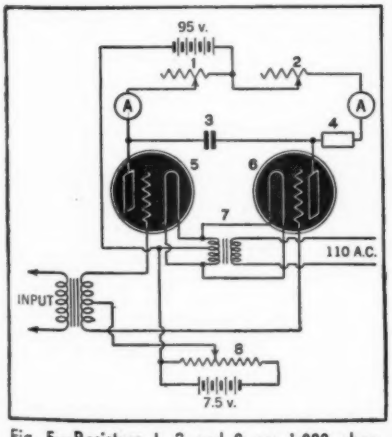


Fig. 5—Resistors 1, 2 and 8 are 1,000 ohms each. 4 is the counter, 5 and 6, thyratrons.

Figure 6 shows a typical experiment that may be made with this type of automatic recorder. *Both the counting chamber and radioactive source are mounted inside a glass bell jar from which air is drawn.* Counts are made per five-minute intervals as the air pressure is changed. Locating lost specimens of radio-active material, studying its characteristics and constructing similar counters for special laboratories include some of the interesting activities associated with this type of electronic device.

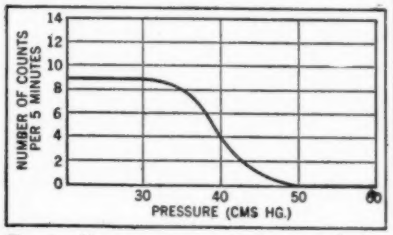


Fig. 6—Air pressure vs. counts per minute.

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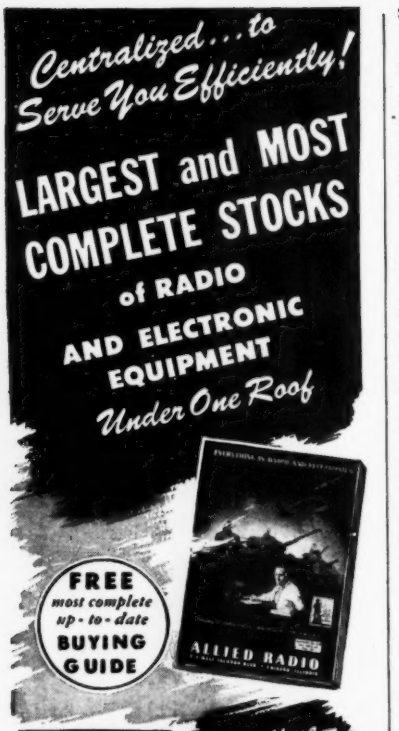

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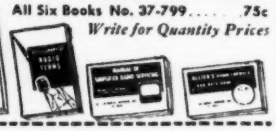

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ALLIED RADIO

AN ELECTRONIC CAPACITY METER

(Continued from page 283)

would cause the oscillators to "block" each other when tuned to the same frequency. For this reason, the coils were shielded, and only stray coupling remained between wires and parts. This small amount of coupling resulted in satisfactory operation of the meter.

The units were built on a heavy metal chassis and the wiring and construction were sturdy. The leads "Y" and "Z" consisted of two very short pieces of No. 14 bus bar wire, clamped to a terminal strip, and placed about an inch apart. This formed a convenient pair of heavy leads against which any two prongs in a tube base can be pressed when measuring the interelectrode capacities of the tube. The conventional phone tip jacks set in the panel could also have been used. Care was taken to keep all wires and parts rigidly in place. Slight vibration or poorly soldered joints cause erratic changes in frequency, which had to be avoided here. Because a high degree of precision was desired, the vernier dial on Condenser "C" was large, had no backlash, and had a very legible dial. Its scale was 0-100.

HOW IT'S CALIBRATED

In calibrating the meter, silvered-mica fixed condensers were used. They were handled with pliers, because the heat of the hand changes their capacity slightly. First, a 100 mmfd. condenser was placed at "X," and the dial on "C" was rotated until zero-beat was indicated in the earphones. The reading was recorded, and the condenser at "X" was removed. Obviously, if an unknown condenser were now placed at "X," and rotation of dial "C" produced a zero beat at exactly the same point, the unknown would have a capacity of 100 mmfd.

By placing two silvered-mica condensers of precisely 100 mmfd. each in series, and then in parallel at "X," new zero-beat readings were taken for 50 mmfd. and 200 mmfd. The dial was then set at 50 mmfd. and a *variable* condenser was placed at "X." Its shaft was rotated until a zero-beat was indicated in the earphones. Thus, set at exactly 50 mmfd., it was then connected in series with a 100 mmfd. condenser, resulting in an effective capacity of 33.3 mmfd. at "X." Dial "C" was turned for zero-beat, and a reading for 33.3 mmfd. obtained. Next, the two condensers in parallel gave a reading for 150 mmfd. Following this general procedure, about 25 readings were taken. The use of a variable condenser in series and parallel with a 100 mmfd. mica yielded a more accurate set of readings than could be obtained from an assortment of fixed condensers. Their tolerance of 1% accuracy, although sufficient for most purposes, could not be relied upon for precision calibration. The coordinate graph of Fig. 3 was then made, from these readings.

A BETTER INSTRUMENT

This triode capacity meter worked satisfactorily, except that a *slight* frequency drift disturbed its accuracy. It was then decided to build a meter of the same type, using two 6SJ7 pentodes in electron-coupled circuits, as in Fig. 2. Several precautions were taken to prevent frequency drift.

First, and very important, the plates were operated at a lower potential. This resulted in cooler operation, and, therefore, less expansion of the tube elements. The expansion is very small, but it changes the interelectrode capacities, resulting in frequency drift. Electron-coupled oscillators are stable, and their frequency is almost entirely independent of changes in plate voltage. However, as an added precaution, "B" batteries were used instead of the conventional power supply. A line voltage regulator was added to stabilize the A.C. filament voltage supply. Also, the cathode was allowed to heat up for 10 minutes before the meter was used. In addition to precautions against frequency drift, a further improvement was added, in the form of band-spread condenser C_2.

C_1 of Figure 2 was then calibrated in much the same way as before, except that C_t was first set so that a zero-beat was obtained with C_1 and C_2 completely open. Then, with C_2 at minimum capacity, the calibrating procedure was completed.

Next, five small trimmer condensers were set at various values below 15 mmfd., using the calibration of C_1. With these known condensers of small capacity, a large number of series and parallel readings were taken on the dial of C_2, C_1 being kept at minimum capacity. It was found that, in this case, small condensers in *parallel* give inaccurate readings because of the tiny capacities of the connecting wires, etc. These parallel readings could not be used in plotting a curve on the graph. However, the five direct readings in addition to ten series combinations provided enough data for the chart in Figure 4. C_1 was now calibrated at 0-365 mmfd., and C_2 at 0-15 mmfd.

At first, broadcast band coils were used in Figure 2. These were not satisfactory on the 0-15 mmfd. range, because the zero-beat point was spread considerably over the dial. When 80 meter coils were substituted, the zero-beat was confined to a thin, hair-line on the dial, with precision accuracy. The size of the coils were not critical, as long as they were identical. The tap on each was adjusted so that the circuit oscillated at any setting of C, and any value of "X."

No frequency drift was noted in the circuit of Figure 2. For even better accuracy in measuring small capacities, a variable condenser smaller than 0-15 mmfd. could be substituted at C_2. This would result in a greater "bandspread" effect, requiring coils of still higher frequency for best results.

SOME EXPERIMENTAL RESULTS

A series of experiments were conducted with the meter of Figure 2. The first involved routine measurements of interelectrode capacities of various radio tubes. These showed slight discrepancies among tubes of the same type and make. For example, the grid-plate capacity was found to be as much as 2 mmfd. plus or minus the manufacturer's rating, in some cases! As a whole, however, the readings conformed closely to the tube manual ratings.

Next, it was decided to determine how the admission of air into the tube would affect these measurements. (In modern thermionic vacuum tubes, more than 99.9% of the air has been exhausted). The grid-plate capacity was first carefully noted. Then a small hole was drilled near the base of the glass envelope. A new measurement of grid-plate capacity now showed a very slight increase. The experiment was repeated several times with different glass tubes. Finally, it was determined that the presence of air increased the interelectrode

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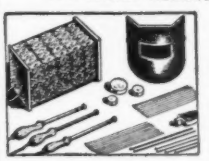

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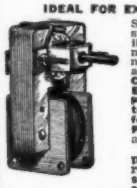

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capacities 1.0005 times. This showed that the dielectric constant of air is slightly higher than that of vacuum. However, the above figure does not express the exact ratio of the two constants, because the leads in the tube were also separated in part, by other dielectric materials. The glass supporting stem furnished a glass dielectric along part of the length of the wires, and there was also bakelite and cement dielectrics between the prongs at the base.

Another experiment was made concerning the nature of grid-to-plate capacity. Theoretically, electrostatic lines of force exist between the grid and plate elements themselves, if there is a difference of potential. These lines also exist between the leads within the tube and between the prongs at the base. Apparently, more lines of force radiate from the plate, expand to the glass envelope, and continue down to the bakelite base to the grid prong and grid lead! This was proved by the following experiment: A tiny hole was drilled through the glass envelope of a tube, as before. The grid-plate capacity was then carefully measured. Next, the glass bulb was broken off, particular care being taken to avoid disturbing the elements and wires in the tube. The grid-plate capacity was then found to be .03 mmfd. *less* than before! The same procedure was tried on several other glass tubes, the results being substantially the same.

The capacities existing among the various leads within a tube are particularly important in U.H.F. In tubes such as the "Acorn" and "Doorknob" types, and the 9000 series, these wires are made short, and are well separated. In some of the more conventional types of receiving tubes, much of the total interelectrode capacities are due to the leads and prongs. For example, the glass envelope was removed from a type 42 tube, and its capacities measured. Then the *elements* were clipped off above the glass supporting stem. What remained was the base, prongs, and the internal leads sealed in the glass stem. These were now measured at the prongs, as before. It was found that of the total interelectrode capacities in a 42 tube, 30% was due to the prongs and leads.

When a cathode is heated, it expands: This expansion would theoretically result in a slight increase in plate-cathode capacity. However, careful measurements with this meter showed an increase of capacity all out of proportion to what would be expected, when the cathode of a type 56 tube was heated. The plate cathode capacity increase *20%* over the cold-cathode reading! Substantially the same results were noted with several other types of tubes. There are several ways of explaining this phenomenon. One theory is that the space-charge surrounding a hot cathode changes the effective dielectric constant of the high vacuum.

In the final design, parts values were as follows: R1 to R4, 100,000 ohms; R5 and R6, 50,000 ohms; C1, 365 mmfd. variable; C2, 15 mmfd. variable; C3 to C6, 100 mmfd. mica; C7, C8, 0.1 mfd. tubular, C9, .01 mfd. tubular. Ct is a 30-mmfd mica variable, Y and Z short No. 14 bus-bar leads and VT's, 2 6SJ7 tubes. L1 and L2 are 27 turns close-wound No. 20 on a 1½-inch form, tapped at the 5th turn.

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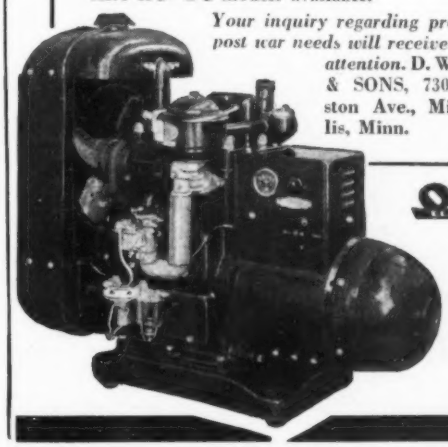

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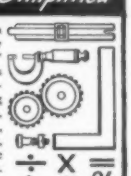

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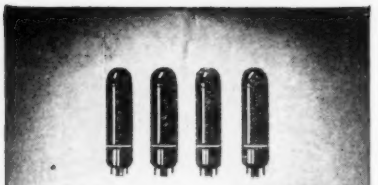

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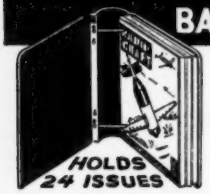

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RADIOCLAST

(Continued from page 275)

and knobs with the other. At a point where the controls are "tuned in" to the disease afflicting the patient, he is supposed to feel a resistance to his stroking, due to the effects of the "vibrations" on the glass plate. Once this "vibratory rate" is discovered, he need only note the readings, look them up in his little black book, and name the disease.

Even this is not necessary. All that need be done is to leave the dials at the "correct" setting, turn the switch from "Diagnose" to "Treat" and simply attach the patient to the output jack with a pair of applicators somewhat similar to those used in diathermy. The disease may then be treated without even troubling to find out what it is. In fact, new and unknown diseases could be treated just as well as such familiar complaints as whooping cough or athlete's foot!

THEORY OF THE MACHINE

According to the literature on the "Radioclast" and similar therapeutic aids, "radionic frequencies are present in all cellular matter. Healthy individuals radiate at a vibratory rate of "49" (whether cycles per week or megacycles per second is not stated). Any deviation from this "normal vitality rate" tends to indicate disease. The function of the Radioclast is to detect this rate of vibration from the "patient," thus determining the disease.

Further, the instrument is supposed to be able to filter and amplify these same frequencies, and return them to the patient. In their amplified form, they are supposed to clash with the original vibrations, breaking them up and thus destroying the disease.

There are only a few things wrong with this theory, in the eyes of the practical radioman. In the first place, no mention is made in any of the literature as to where in the spectrum these frequencies may be found. The photographs show a set of coils capable of tuning from (roughly) 20 to something over 1,000 meters. (The exact low-frequency range would depend on whether the largest coil is double- or triple-banked, a point difficult to determine from the photographs.)

We should naturally expect the "vibratory rates" or frequencies, to fall somewhere in the bands over which the set is supposed to operate. However, *absolutely no information* on this subject is forthcoming from the manufacturer. The Manual which goes with the machine does in fact print a spectrum of all waves from zero frequency up to the cosmic rays. Explaining the chart, the statement is made that "the energies generated by the Radioclast are all located in the Hertzian band, and have wave-lengths longer than that of light . . . have definite frequencies capable of being measured with a wave meter."

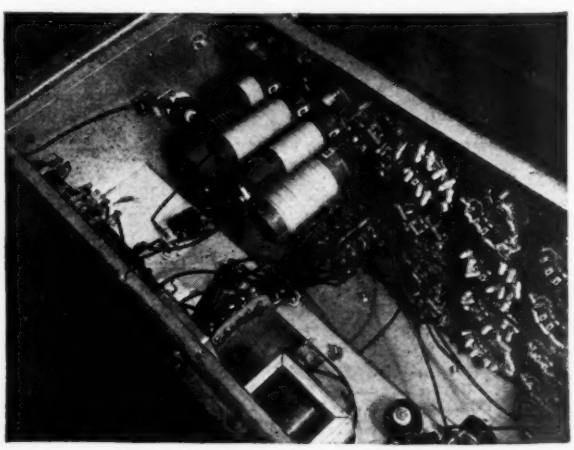
If this is the case, why not name them? Then scientists would be able to verify the statements of the Radioclast manufacturers, and they would become millionaires overnight! But no! not only do they avoid coming out with such definite information on the "rate of vibration" of our illnesses, but no one else is able to detect any of these vibrations supposed to be measurable with a wavemeter.

A competent radio engineer, Mr. Robert L. Batts of the Indianapolis Police Radio Bureau, after spending several weeks investigating the device, announced that with the help of the best instruments, including an oscillograph with sensitive amplifiers, he was unable to find *"any kind* of energy or vibration frequency on the detector plate" (from which the "doctor" is supposed to determine such frequency).

PURE RESISTANCE TUNING

An even more impressive argument to the practical radioman is that the three knobs marked VR (vibration rate) which are "tuned" to discover the frequency of the disease, are simply rheostats! They are 10-point switches, across which resistors are so connected as to give steps of 1, 10 and 100 ohms. An ordinary decade box, in other words, and no more capable of tuning one frequency out and another in than is the volume control of your receiver. The only real tuning control of the device, the variable condenser which tunes the 807 oscillator, is in fact used—in "treatment"—being set to produce "vibrations" which neutralize those "tuned in" by the three variable resistors!

These are not the only resistance controls used to determine frequencies. Another decade group is marked "Visc." and is supposed to measure the visceral rate, or frequency of the internal organs of the body. Still another group is marked "X VR" (possibly for checking "vibratory rates" with the help of an X-ray?). The fourth row, marked "measure," which is



Under-chassis view of the radionic cure-all. The cocoonlike objects are resistors, mounted on the terminals of several multi-point tap switches. A very fine set of all-wave coils is the most interesting feature of this not-too-useful instrument.

supposed to be able to indicate to the skilled operator the intensity of the disease, at least represents a function for which resistors might conceivably be used. If any currents *were* present, they could be cut down to a standard and checked, by means of a decade box. Unfortunately, investigators have been absolutely unable to discover *any* currents in the circuits supposed to measure . . . something.

A third interesting point appears in the instructions on the use of the machine. After explaining the importance of "vibratory rates" and their selection, the instructions blandly state that for a general treatment, "all dials may be set at zero." Under these conditions, it is stated, the "construction vibrations are patterned directly from the disease vibrations." No trouble with out-of-tune circuits here. Just disregard them! The thoughtful engineer would indeed be willing to admit that, for all the tuning the various sets of variable resistors might be capable of, it would certainly be just as well to leave them all at zero!

Even the ancient and comparatively crude Abrams device was subtler on this particular point—when "general treatments" were given, a drop of the victim's blood was placed between two "condenser plates" in the machine, thus presumably giving automatic tuning to whatever "VR" was indicated by the "radionic" emanations of the diseased droplet.

THE RADIOCLAST IS A FAKE

On a basis of the foregoing, therefore, it is hardly necessary to go into the statements of radiomen, professors of physics and others who submitted to tests with the machine, and found that they were diagnosed as having various imaginary troubles. They also discovered that diagnosis went on just as well if they surreptitiously released the electrode supposed to conduct "vibrations" from their bodies to the machine!

On a purely technical and electrical basis, it is possible to state that the machine cannot detect "radionic vibratory rates" or amplify, purify and retransmit them back into the human body again. It is reasonably safe to assume that the machine was never designed for that purpose, but to obtain as much money as possible from misguided practitioneers and unfortunate patients. It is a fake, pure and simple!

(On second thought, the machine may not be a total loss, after all. Fitted with a crystal, and with the band-switch and most of the coils thrown away, a fair short-wave amateur transmitter might be built up around the 807 tube. The rest of the instrument could be remodelled into a Wheatstone Bridge, using the decade resistors and the microammeter already installed.)

Should the makers of the instrument (who were asked for technical information on the instrument but regretted they could not furnish it) feel that this story does not do their product complete justice, *Radio-Craft* has the following proposition:

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Our offer is made with no trepidation on our part, as both a study of the "instrument" and our experience with promoters of similar devices in the past assure us that *this challenge will never be accepted.* The "scientists" who develop fakes of this type fear technical investigation as much as they fear fraud orders.

As to the operators of these machines—at best they are examples of that form of self-deception so notable in the operation of the "weegee" board, the "dowsing" rod and similar devices; at worst shameless charlatans intent on filling their pockets at the expense of that portion of mankind least able to support such parasites—the sick and suffering who are not only bled financially but are led still further away from health through the time and money wasted on such useless "treatment."

(Acknowledgement is made to the Better Business Bureau of Indianapolis for photographs and information; to Robert L. Batts, Supervisor of Radio, Indianapolis Police Department, for a complete technical report and schematic of the Radioclast, and to the Palmer School of Chiropractic, Davenport, Iowa, for information on exposés of earlier devices of this nature.)

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(Continued from page 288)

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7.32	GRJ	LONDON, ENGLAND; 12:15 to 12:45 am, North America beam.
7.565	WKLJ	NEW YORK CITY; North African beam, 8:15 pm to 5 am.
7.565	KWY	SAN FRANCISCO, CALIF.; 8:30 to 10:30 am daily, Sundays, 9:30 to 10:30 am.
7.575	WRUA	BOSTON, MASS.; North African beam, 4:45 to 7:15 pm; 7:30 to 11:45 pm.
7.805	WRUL	BOSTON, MASS.; North African beam, 2:15 to 5:45 am.
7.820	WKRD	NEW YORK CITY; European beam, 4:45 pm to 4:45 am.
7.950	——	ALICANTE, SPAIN; off at 6 pm daily.
8.000	——	"A E F RADIO IN ALGIERS"; heard at 4:15 pm.
8.000	——	ATHENS, GREECE; heard 3 to 6 pm daily.
8.030	FXE	BEIRUT-LEBANON (SYRIA); 1 to 4:30 pm.
8.035	CNR	RABAT, MOROCCO; heard Sunday 5 pm.
8.220	——	DAKAR, SENEGAL (French West Africa); off at 5:04 pm.
8.484	XPSA	KWEIYANG, CHINA; 7:30 am to 12 noon.
8.664	COJK	CAMAGUEY, CUBA; 5 to 6 pm; irregular.
8.70	COCO	HAVANA, CUBA; daytimes.
8.83	COCQ	HAVANA, CUBA; daytimes.
8.930	KES2	SAN FRANCISCO, CALIF.; 6:15 am to 1 pm; Oriental beam.
8.955	COKG	SANTIAGO, CUBA; 7:30 am to 11 pm.
9.03	COBZ	HAVANA, CUBA; 9 am to 12:18 am.
9.125	HAT4	BUDAPEST, HUNGARY; 2 to 6 pm; 9 to 11 pm.
9.130	HI2G	CIUDAD TRUJILLO, DOMINICAN REPUBLIC; early evenings.
9.185	COCO	HAVANA, CUBA; evenings.
9.250	COBQ	HAVANA, CUBA; 4 to 7 pm.
9.255	——	BUCHAREST, ROUMANIA; 4 to 5 pm; news (English) 4:50 pm.
9.26	GSU	LONDON, ENGLAND; Near East, Africa, and Gibraltar beam, about noon.
9.29	HI2G	CIUDAD TRUJILLO, DOMINICAN REPUBLIC; Sunday afternoons.
9.295	COCX	HAVANA, CUBA; daytimes.
9.35	COBC	HAVANA, CUBA; 9 am to 1:15 am.
9.437	COCH	HAVANA, CUBA; 7 am to 1 am.
9.455	GRU	LONDON, ENGLAND; 1:30 to 5 am; 6 to 10:30 am; 1:30 to 2:15 pm; 3 to 6 pm; 7 to 10:45 pm; 11:45 pm to 12:45 am.

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9.470	CR6RA	LOUANDA, ANGOLA; 7:30 to 8:45 am; 3:30 to 5 pm.
9.480	CP38	LA PAZ, BOLIVIA; 7 to 11 pm.
9.485	——	"SLOVAK FREEDOM STATION"; Saturdays, 4:30 to 4:42 pm.
9.490	KRCA	SAN FRANCISCO, CALIF.; 1 am to 1 pm, Oriental beam.
9.490	WCBX	NEW YORK CITY; Latin American beam, 5 to 11:30 pm.
9.495	OIX2	HELSINKI, FINLAND; 4 to 5 pm.
9.50	XEWW	MEXICO CITY, MEXICO; 9 am to 3 am.
9.505	JLG2	TOKYO, JAPAN; North American beam, 11 am to 2:40 pm; 11 pm to 4 am.
9.510	GSB	LONDON, ENGLAND; 2 to 3 pm.
9.52	DXLI3	PARIS, FRANCE; relays Berlin to North America, 5:30 pm to midnight.
9.530	WGEA	SCHENECTADY, NEW YORK; 3:30 to 6 am, European beam.
9.530	WGEO	SCHENECTADY, NEW YORK; East South American beam, 5:30 pm to midnight; European beam, 3:15 to 5:15 pm.
9.535	——	UNITED NATIONS RADIO—ALGIERS; heard Signing off Sunday at 4 pm; other times in evenings.
9.535	SBU	MOTOLA, SWEDEN; Daily, 2:30 to 5:15 pm; 5:20 to 5:35 pm; 9 to 10 pm; Sundays, 2:30 to 5:15 pm; 5:20 to 5:40 pm.
9.535	HER4	BERN, SWITZERLAND; North American beam, 7:30 to 9 pm; 9:30 to 11 pm.
9.535	JZI	TOKYO, JAPAN; 1:20 to 4 am; 8 to 9:15 am; 10 am to 2:40 pm.
9.54	VLG2	MELBOURNE, AUSTRALIA; Eastern North American beam, 1:10 to 1:40 am; 10 pm.
9.54	MTCY	HSINGKING, MANCHUKUO; 9 to 11 am.
9.543	XEFT	VERA CRUZ, MEXICO; 11 am to 2 am.
9.555	XETT	MEXICO CITY, MEXICO; 10 am to 2 am.
9.550	GWB	LONDON, ENGLAND; news at 2:30 am.
9.562	OAX4T	LIMA, PERU; 7 to 10 am.
9.565	——	MOSCOW, U. S. S. R.; 6 to 7:30 am; 5:15 to 6:45 pm; 10 to 11:15 pm.
9.565	JRAK	PARAO, PALAU GROUP (Japanese); 7 to 9:30 pm.
9.57	KWIX	SAN FRANCISCO, CALIF.; South American beam, 8 pm to 12:45 am; Oriental beam, 1 to 2:45 am; 7:30 am to 4:45 pm.
9.570	KWID	SAN FRANCISCO, CALIF.; Australian beam, 3 to 6:15 am.
9.570	WRUS	BOSTON, MASS.; North Africa, 4:45 to 7:15 pm.
9.580	GSC	LONDON, ENGLAND; North America beam, 5:15 to 10:15 pm.
9.58	VLG	MELBOURNE, AUSTRALIA; 11 am to 12:10 pm.
9.590	WCDA	NEW YORK CITY; European beam, 6 to 7:30 am.
9.595	——	ATHLONE, IRELAND; 5:10 to 5:30 pm.
9.600	GRY	LONDON, ENGLAND; 1 to 2:45 am; 3:30 to 10:30 am; 2:15 to 5 pm; 5:15 to 6:45 pm.
9.600	CE960	SANTIAGO, CHILE; 8 pm to midnight.
9.608	ZRL	CAPE TOWN, SOUTH AFRICA; 11 to 11:45 am.
9.610	DXB	BERLIN, GERMANY; 2 to 5:45 pm; 5:50 to 7 pm; 10 pm to midnight.
9.610	ZYC8	RIO DE JANEIRO, BRAZIL; 6 to 11 pm.
9.615	XERQ	MEXICO CITY, MEXICO; 10 am to midnight.
9.615	TIPG	SAN JOSE, COSTA RICA; "La Voz de la Victor"; heard mornings and evenings.
9.620	OPL	LEOPOLDVILLE, BELGIAN CONGO; after midnight; used by "Radio National Belge."
9.620	——	ADDIS ABABA, ETHIOPIA; 11:30 am to 12:15 pm.
9.62	——	VICHY, FRANCE; North American beam, 8:15 pm.
9.630	2RO3	ROME, ITALY; off since September 8th, 1943.
9.64	LRI	BUENOS AIRES, ARGENTINA; "Radio Belgrano"; evenings.
9.64	KZRH	MANILA, PHILIPPINES; 7 to 9:30 am
9.640	CXA8	MONTEVIDEO, URUGUAY; 5 pm to midnight; to 1 am on Sundays.
9.64	COX	HAVANA, CUBA; 1 to 11:15 pm.
9.645	LLH	OSLO, NORWAY; 10 to 10:45 pm.
9.645	JLT2	TOKYO, JAPAN; noon to 2 pm.
9.650	DJW	BERLIN, GERMANY; 2 to 5:45 pm; 5:50 pm to 2 am.
9.650	WCDA	NEW YORK CITY; European beam, 3:30 to 7 pm.
9.660	VUD6	DELHI, INDIA; news irregularly at 8 am.
9.660	VLQ3	BRISBANE, AUSTRALIA; Sunday to Friday, 3:30 to 7 pm; 8:45 pm to 3:35 am; Saturdays, 3:45 pm to 3:35 am.
9.660	LRX	BUENOS AIRES, ARGENTINA; "Radio El Mundo" relaying LRI; 5 pm to midnight.
9.660	HVJ	VATICAN CITY; 11 am to 1:45 pm; 7:45 to 8:10 pm.
9.665	XGOI	SHANGHAI, CHINA; operated by Japanese; 8 to 9 am.
9.665	VLW4	PERTH, AUSTRALIA; 8:15 to 9:55 pm; to Southeast Asia.
9.665	——	ITALIAN UNDERCOVER STATION; 7 to 7:20 pm.
9.670	WRCA	NEW YORK CITY; Brazilian beam, 8 to 11:30 pm.
9.670	WNBI	NEW YORK CITY; European beam, 12:15 to 2 am; 6 to 7:30 am; 3:45 to 5:15 pm.
9.675	DJX	BERLIN, GERMANY; 11:20 am to 5:33 pm.
9.675	JVW2	TOKYO, JAPAN; 5 to 8 am; 10 am to 12:15 pm.
9.680	XEQQ	MEXICO CITY, MEXICO; 10 am to 2:45 am.
9.68	VLW6	PERTH, AUSTRALIA; 6 to 10:50 am; 9 pm to midnight.
9.685	TGWA	GUATEMALA CITY, GUATEMALA; 9:55 pm to 12:45 am.
9.690	GRX	LONDON, ENGLAND
9.69	LRAI	BUENOS AIRES, ARGENTINA; Fridays only, 5 to 5:30 pm; "Radio Del Estado."
9.693	JIE2	TAIHOKU, FORMOSA; 8:30 to 10 am
9.700	FIQA	TANANARIVE, MADAGASGAR; noon to 1 pm.
9.700	WRUW	BOSTON, MASS.; Caribbean beam, 6:15 to 7:15 pm; European beam, 2:45 to 5:55 pm.
9.700	WRUS	BOSTON, MASS.; Mexican beam, 7:30 pm to 2 am; North African beam, 6 to 7:30 am.
9.705	——	FORT DE FRANCE, MARTINQUE; 5 to 8:30 pm.
9.715	OAX4K	LIMA, PERU; 7 to 9 pm.
9.720	XGOA	CHUNGKING, CHINA; 8 to 11 am.
9.720	——	"RADIO PATRIE"; also known as "Radio Resistance" 3 to 3:12 pm.
9.720	PRL7	RIO DE JANEIRO, BRAZIL; "Radio Nacional"; 4:10 to 9:50 pm.
9.724	CSW	LISBON, PORTUGAL; African beam, 3 to 6:30 pm.
9.730	CE970	VALPARAISO, CHILE; 7 to 11 pm.
9.740	CSW7	LISBON, PORTUGAL; North American beam, 9 to 10 pm.
9.750	——	ROME, ITALY; off since September 8th, 1943.
9.750	WKLJ	NEW YORK CITY; North African beam, 5:15 to 7 am; 3:30 to 8 pm.
9.755	——	"RADIO INCONNU"; 3 to 3:11½ pm; chimes or bells.
9.760	——	"DEUTSCHER KURZWELLEN SENDER ATLANTIC"; 1:30 to 2 pm Sunday; 3:30 to 3:58 pm; 4:30 to 4:58 pm.
9.765	OPL	LEOPOLDVILLE, BELGIAN CONGO; after midnight; used by "Radio National Belge."
9.780	——	FRENCH EQUATORIAL AFRICA; 10:30 to 11 pm; irregular.
9.780	——	ITALIAN UNDERCOVER STATION; 4 to 4:11 pm.
9.785	OPL	LEOPOLDVILLE, BELGIAN CONGO; 5:45 to 6:35 pm; 8:15 to 8:45 pm; other times.
9.825	GRH	LONDON, ENGLAND; 1 to 4:30 am; 11:30 am to 12:45 pm.
9.830	GRX	LONDON, ENGLAND
9.833	COCM	HAVANA, CUBA; 10 am to 11 pm.
9.833	XPRA	KUNMING, CHINA; 8 to 9 am.
9.835	——	"HUNGARIAN NATIONS RADIO"; speaks German; Sundays, 2:15 to 2:28 am; 9:15 to 9:27 am; 2:15 to 2:27 pm; 3:15 to 3:27 pm; 7:15 to 7:27 pm.
9.845	——	"RADIO NAZIONALE FASCISTI"; 3:30 to 5:57 pm; 6 to 6:55 pm.
9.860	EAQ	MADRID, SPAIN; 1 to 3 pm; 6:40 to 7:13 pm; 7:20 to 8 pm.
9.865	——	MOSCOW, U S S R; 7 to 8 am; 10:40 am; 7 to 7:25 pm; 8 to 8:45 pm.
9.870	——	"PRAHEVA"; 5 to 5:07½ pm; opens with train whistle and closes with three train whistles; 7 language.
9.880	CR7BE	LOURENCO MARQUES, MOZANBIQUE; 6 to 8 am; 3 to 5 pm.
9.880	——	MOSCOW, U S S R; 11 am to noon.
9.895	——	"BULGARIAN FREEDOM STATION"; 2:15 to 2:28 pm; 3:15 to 3:30 pm.
9.897	WKRD	NEW YORK CITY; European beam, 5 to 6:45 am.
9.897	KROJ	LOS ANGELES, CALIF.; N.E.I.-Orient beam, 10:15 pm to 3:45 am; 11:15 am to 2:15; Australian beam, 4 to 9 am.

(Continued on following page)

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LITTLE GIANT MAGNET

Lifts 5 lbs. easily. Weighs 4 oz. Made of ALNICO new high-magnetic steel. Complete with keeper. World's most powerful magnet ever made. The experimenter and hobbyist will find hundreds of excellent uses for this high quality permanent magnet. Measures 1¾" x 1½" Ship. Wt. ¾ lbs.

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YOUR PRICE $1.25

VARIABLE SPEED UNIVERSAL MOTOR

For 110 Volts, A.C. or D.C. All Nickel Plate

Edison Dictaphone motor 1/50 H.P. Used but in excellent condition. For buffing, polishing, drilling, sawing; runs phonographs, fans, models, blowers, lathes, etc. Special control permits variable speeds up to 1500 r.p.m. 5/16" shaft extends from both sides of motor. Cast iron base has 3 screw mounting holes. Height 4½"; length 7½"; width 5½". Shaft is 1¾" long on one side. Ship. Wt. 8 lbs.

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POWER ADJUSTABLE RHEOSTAT

Here is an excellent rheostat used especially to regulate speeds of small motors, such as our **Handy Workshop Outfit.** This rheostat can be used in connection with motors up to 1/20 h.p.

This fine rheostat is wire-wound on porcelain insulation. The black enamel steel casing is perforated for ventilation. Adjustable handle regulates speed of motor easily and smoothly. Size 5"x2¾" overall. Ship. Wt. 2 lbs.

ITEM NO. 153
YOUR PRICE $1.45

AMAZING BLACK LIGHT!!

Powerful 250-Watt Ultra-Violet Source

The best and most practical source of ultra-violet light for general experimental and entertainment use. Makes all fluorescent substances brilliantly luminescent. **No transformers of any kind needed.** Fits any standard lamp socket. Made with special filter glass permitting only ultra-violet rays to come through. Brings out beautiful opalescent hues in various types of materials. Swell for amateur parties, plays, etc.; to obtain unique lighting effects. Bulb only. Shp. Wt. 1 lb.

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Mc.	Call	Location and Schedule
9.897	WKRX	NEW YORK CITY; North European beam, 6 to 8:45 pm.
9.935	——	"RADIO MEDITERRANEAN"; heard Sundays, 1:58 to 2:30 pm.
9.958	HCJB	QUITO, ECUADOR; 9 to 9:45 am; as late as 11:20 pm.
9.960	——	"GERMAN CATHOLIC STATION"; 5:15 to 5:30 pm.
10,000	WWV	BELTSVILLE, MARYLAND; on the hour every hour; frequency test signals.
10.005	——	VOICE OF FREE ARABS; Sundays, 2:15 to 2:34 pm; 3:15 to 3:35 pm.
10.010	——	"BULGARIAN FREEDOM STATION"; 2:15 to 2:28 pm.
10.050	XBHX	MEXICO CITY, MEXICO; 8 am to 8 pm daily.
10.065	MTCY	MANCHUKUO; 1:30 to 3 am.
10.130	HH3W	PORT AU PRINCE, HAITI; 1 to 5 pm; 7 to 11 pm.
10.22	PSH	RIO DE JANEIRO, BRAZIL; 7 to 8:15 pm; 8:30 to 9 pm.
10.260	XGAP	PEIPING, CHINA; under Japanese operation; 9 to 11 am.
10.285	ZNR	ADEN, ARABIA
10.290	DZR	BERLIN, GERMANY; 6 pm to midnight.
10.445	——	MOSCOW, U S S R; 7:40 to 8:20 am; 8:30 to 11 pm.
10.543	DZD	BERLIN, GERMANY; 5:50 pm to midnight.
10.620	KES2	SAN FRANCISCO, CALIF.; 1 to 6 am, N.E.I.-Oriental beam.
10.75	——	RIO DE JANEIRO, BRAZIL; carries PRL8 program.
10.840	KWV	SAN FRANCISCO, CALIF.; Australian beam, 2 to 4:45 am; South American beam, 5 to 7 am.
11.000	PLP	BANDOENG, JAVA.
11.040	CSW6	LISBON, PORTUGAL; Brazilian beam, 6:45 to 8:45 pm.
11.145	WRUA	BOSTON, MASS.; North African beam, 6 to 7:30 am; 7:45 am to 4:30 pm.
11.6	——	ROUMANIAN FREEDOM STATION; 1:45 to 1:55 pm; 4:15 to 4:25 pm.
11.616	COK	HAVANA, CUBA; "The Voice of Liberty"; noon to midnight.
11.633	——	"HUNGARIAN NATIONS RADIO"; 1:15 to 1:27 pm.
11.65	COCX	HAVANA, CUBA.
11.675	OPL	LEOPOLDVILLE, BELGIAN CONGO; 1 to 6:15 pm.
11.68	GRG	LONDON, ENGLAND; 6 to 7 pm.
11.700	HP5A	PANAMA CITY, PANAMA; news (English) 7:15 pm.
11.700	GBW	LONDON, ENGLAND
11.705	CBFY	VERCHERES, CANADA; 11 am to noon.
11.720	CJRX	WINNIPEG, CANADA; noon to 4:30 pm.
11.72	PRL8	RIO DE JANEIRO, BRAZIL; "Radio Nacional" nightly beamed to North America, 10 to 11 pm; off Sundays.
11.725	JVW3	TOKYO, JAPAN; 9 am to 2:40 pm.
11.730	GVV	LONDON, ENGLAND; heard at 9 am and 12:45 pm to India.
11.730	WRUL	BOSTON, MASS.; Caribbean beam, 6:15 to 7:15 pm; Central American beam, 7:30 pm to 2 am; European beam, 2:30 to 5:55 pm.
11.730	WRUW	BOSTON, MASS.; European beam, 8 to 10 am.
11.740	COCY	HAVANA, CUBA; 11 am to 1 pm.
11.750	GSD	LONDON, ENGLAND.
11.77	DJD	BERLIN, GERMANY; North American beam, evening transmissions.
11.775	——	FRENCH INDO CHINA; "Radio Saigon"; 10 to 11:30 am.
11.775	MTCY	HSINKING, MANCHURIA; 1:30 to 3 am.
11.78	GVU	LONDON, ENGLAND; North American beam, 6:30 to 7 pm.
11.790	HP5G	PANAMA CITY, PANAMA; 9:45 pm to 7
11.790	——	"RADIO PRAHEVA"; 11 to 11:08 am; noon to 12:07 pm; 1 to 1:07 pm; 2 to 2:07 pm; Talks about law and order during each transmission.
11.79	KGEI	SAN FRANCISCO CALIF.; 5 pm to 12:45 am; South American beam.
11.800	HI3X	TRUJILLO, DOMINICAN REPUBLIC; testing at 12:15 pm.
11.80	JZJ	TOKYO, JAPAN; 11 pm to 4 am.
11.805	COBH	HAVANA, CUBA; afternoons.
11.81	2RO22	ROME, ITALY; off since September 8th, 1943.
11.820	GSN	LONDON, ENGLAND; after 10 am.
11.830	WCRC	NEW YORK CITY; Latin American beam, 5:30 pm to midnight; European beam, 7 am to 5:15 pm.
11.840	COBH	HAVANA, CUBA; mornings, afternoons, and evenings; relays CMCH and CMCX.
11.847	WGEA	SCHENECTADY, NEW YORK; European beam, 6:15 am to 4:45 pm; Brazilian beam, 5 to 8:15 pm.
11.86	GSE	LONDON, ENGLAND; Near East, Africa, and Gibraltar beam, about noon.
11.870	WBOS	BOSTON, MASS.; European beam, 5:45 to 7 am; 3:15 to 5:15 pm.
11.870	WNBI	NEW YORK CITY; East South America beam, 7 pm to midnight; Sundays only, 7:45 pm to midnight.
11.88	LRR	ROSARIO, ARGENTINA; heard evenings; CBS news in Spanish, 6:30 to 6:45 pm.
11.893	WRCA	NEW YORK CITY; European beam, 5 to 8:45 am; 3 to 4:45 pm
11.895	OAX10	MONTEVIDEO, URUGUAY; "Radio Electrica de Montevideo"; heard evenings, about 7:30 pm; relays CX6.
11.900	XGOY	CHUNGKING, CHINA; Asia-Australia-New Zealand beam, 6 to 6:30 am; East Russia beam, 6:30 to 7 am; Japan beam, 7 to 7:30 am; European beam, 11:35 am to 12:30 pm.
11.900	CXA10	MONTEVIDEO, URUGUAY; evenings.
11.905	——	UNITED NATIONS RADIO; ALGIERS; signs off at 4 pm; same as 9.535 megacycles.
11.910	2RO	ROME, ITALY; off since September 8th, 1943.
11.970	FZI	BRAZZAVILLE, FRENCH EQUATORIAL AFRICA; "Radio Brazzaville"; 4:45 to 8 pm.
12.000	——	LISBON, PORTUGAL; Oriental beam, 8 to 10 am.
12.060	FFZ	SHANGHAI, CHINA; heard at 8 am.
12.115	ZNR	ADEN, ARABIA; off at 1:16 pm.
12.235	TFJ	ICELAND; heard early mornings; irregular.
12.445	HCJB	QUITO, ECUADOR; "Voice of the Andes"; 5 to 11 pm, except Monday; in English at 10 pm.
12.967	WKRD	NEW YORK CITY; North African beam, 12:45 to 4:30 pm.
12.967	WKRX	NEW YORK CITY; North African beam, 6 to 8 am.
14.460	DZH	BERLIN, GERMANY; 10 to 10:45 am.
14.480	——	EL SALVADOR; 1 pm to ?
15.070	GWC	LONDON, ENGLAND; 10 to 11 pm.
15.105	JLG4	TOKYO, JAPAN; 2 to 4 am, heard some evenings.
15.110	GSF	LONDON, ENGLAND.
15.11	DJL	BERLIN, GERMANY.
15.11	——	MOSCOW, U.S.S.R.; 9:15 pm and 11:15 pm; 5:15 to 5:40 pm.
15.130	WRUS	BOSTON, MASS.; North African beam, 7:45 am to 4:30 pm.
15.14	GSF	LONDON, ENGLAND; Near East, Africa and Gibraltar beam, about noon.
15.150	WRCA	NEW YORK CITY; Brazilian beam, 5 to 7:45 pm.
15.150	WNBI	NEW YORK CITY; European beam, 7:45 am to 3:30 pm.
15.155	SBT	STOCKHOLM, SWEDEN; heard daily, 11 am to 2:15 pm.
15.165	PRE9	FORTALEZA, BRAZIL; evenings.
15.170	TGWA	GUATEMALA CITY, GUATEMALA; daytimes.
15.190	KROJ	LOS ANGELES, CALIF.; N.E.I.-Oriental beam, 2:30 to 8:45 pm.
15.190	WKRD	NEW YORK CITY; Central Africa beam, 7 to 9 am.
15.190	WKRX	NEW YORK CITY; European beam, 9:45 to 11 am; North European beam, 11:15 am to 12:45 pm; Central Africa beam, 1 to 5 pm.
15.20	DJB	BERLIN, GERMANY; North American beam, 7 to 9:45 am; 5:50 to 8:30 pm.
15.210	WBOS	BOSTON, MASS.; European beam, 7:15 to 9:30 am; 10:45 am to 3 pm; (5:15 pm on Saturdays); North European beam, 9:45 to 10:30 am; East South American beam, 5:30 to 8:15 pm.
15.225	JTL3	TOKYO, JAPAN; 6:15 to 8:15 pm; news in English at 6:20 and 7:20 pm.
15.240	TPC5	VICHY, FRANCE; 11:15 am to 1:30 pm.
15.250	WLWK	CINCINNATI, OHIO; European beam, 8:30 am to 5:15 pm; West South American beam, 5:30 to 8:15 pm.
15.260	GSI	LONDON, ENGLAND; 11 am to noon; 4 to 5 pm.
15.270	WCBX	NEW YORK CITY; European beam, 7 am to 4:45 pm.
15.29	KWID	SAN FRANCISCO, CALIF.; Oriental beam, 1 to 2:15 am; South American beam, 1 to 9 pm.

(Continued on page 318)

Technotes

. . . . PHILCO 116, TRANSFORMER BUZZ

Oscillation and intermittent howling may be traced to the tube shields on this model. They are fastened to the chassis by plain spread lugs which do not always make good contact.

Good grounds to each of the shields will clear up this trouble.

Buzzing lamination trouble may be eliminated by loosening the clamping bolts slightly, then applying enough varnish to soak the core, afterward tightening the bolts again. *Do not use shellac,* as this ruins the enamel coating of the wire.

B. HENDERSON,
Aragon, Ga.

. . . . PHILCO 41-608P

Weak on phonograph; O.K. on radio. Trouble due to a weak 7Y4 rectifier tube. Replace.

. . . . RCA 9K and K80

If this set is intermittent it is usually due to defective .01 coupling condensers.

. . . . U. S. RADIO AND TELEVISION CORP. MODELS 46 and 47.

No control of volume and low voltages on screen of 24's is often due to a very leaky .5 mfd. 400-volt condenser in the screen-grid circuit.

The remedy is, of course, new screen-grid by-pass condensers.

. . . . RCA BP10

Oscillation. Caused by defective 10 mfd. 60-volt condenser in screen-grid and plate circuit. (C17) Replace.

. . . . G-E LB530

If rectifier step-down transformer T3 gets hot when on charging position, check copper oxide rectifier. One or both discs may be defective and they can be replaced. If permitted to remain, the step-down transformer will overheat and burn out.

H. HUDSON,
No address.

. . . . AUTO RADIO ON A.C.

I have a 1936 Ford Philco auto radio which operates very satisfactorily on A.C. by simply applying 6 volts A.C. to the battery terminals, discarding the vibrator, and connecting one-half the vibrator transformer primary across the 6 volts A.C.

A heavy transformer must be used to supply the several amperes required at 6 volts.

C. H. LILIE,
St. Mary, Ohio

(This system should work on most sets using a rectifier tube in the vibrator transformer secondary high-voltage circuit.—Ed.)

. . . . G-E LF-115, 116, LFC-118, ETC.

Set dead on radio, plays O.K. on phonograph.

This is usually caused by a shorted condenser, C32, .02-mfd, 400 volts, from plate supply to cathode of converter. It usually also burns out the cathode resistor.

C31, the screen by-pass condenser of the same tube, also breaks down frequently. Replace these condensers with 600-volt.

STANLEY LUFFY,
Verona, Penna.

. . . . RCA MODEL 2XE

Set does not play; audio section O. K. According to the diagram, the ground connections are isolated from the chassis. It will be found however, that two of the oscillator coil connections and the variable condenser rotor are grounded to it. Trouble is an open by-pass condenser between the common ground and chassis, which opens the return from the R.F. and oscillator stages.

. . . . PHILCO 1942 RECORD-CHANGERS

Slippage at belt drive has been found in cases where the bolts holding trunnion bearing were stripped causing bearing to shift back.

. . . . ZENITH 7G605

Ringing sound (microphonics) as set is playing. Is caused in most cases by bad 1LD5 tube. Try several until you find the one least microphonic, as they have a tendency to be so.

. . . . PHILCO 38-116XX

Fading and distortion on this set has often been cured by replacing the 6J5G. It is worth while to try this before making any other tests if one of these models comes in with complaint of distortion or fading.

DANIEL DELOI,
Brooklyn, N. Y.

. . . . PHILCO 38-8

And other sets using a 6K5.

The 6K5 on this set had burned out and I could not find another. The 6F5 has some of the characteristics of a 6K5, so I tried that. Only one change had to be made—the plate lead was changed from Prong 3 to Prong 4.

This solved my problem and fixed the set.

J. H. DEW,
Nixon, Texas.

. . . . A.C.-D.C. 3-WAY PORTABLES

On many of these radios which use 1A7 oscillators I have received complaints that the sets operate on battery but not on A.C. Invariably these are from sections where the line voltage is lowered by having too many electrical appliances and tenants on the same line.

This can often be cured by using a *new* rectifier tube, especially in sets using 50Y6 or 117Z6's. The new tube has a better output on low A.C. voltages.

J. J. CECIL,
San Antonio, Texas.

. . . . PHILCO; 1941 AND 1942 MODELS WITH AUTOMATIC TUNING

Trouble: Push-buttons dead (no reception on automatic position).

Remedy: Replace dual 370 mmf. condenser mounted on wave-band switch.

C. E. BARNES,
Norfolk, Va.

. . . . EMERSON U-6-B

One side chassis hot, extreme distortion. This is not due to trouble in the resistor, as might be assumed. One side of the pilot light is shorting to the chassis.

A. M. GREENKY,
New York City.

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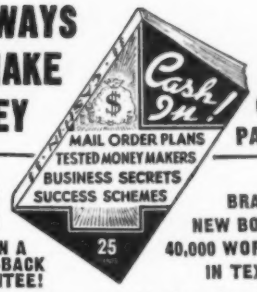

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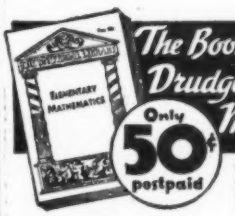

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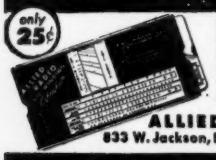

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The Mail Bag

SUGGESTIONS FROM AN OLD-TIMER

Dear Editor:

I have been a continual reader of Gernsback Publications dating back to the ELECTRICAL EXPERIMENTER, so you can identify me as being an old timer dyed in the wool.

Many times I felt the urge to write in regard to the Radio as a profession, there being a few things I might suggest in reference to all servicemen being better organized. Some good does comes from any war and since tubes and parts have been scarce it may have given those who really know their stuff a chance to be recognized. Heretofore a young boy or handy man or screw-driver mechanic have been able to go to our jobbers or supply stores and buy tubes and parts at serviceman's prices and at this time it is just about out of the question due to the scarcity of these commodities.

If only those who are engaged in the business are able to do this, things might be different. Right now the public is only too glad to look up to the serviceman in this time of need.

Why couldn't it be arranged so after the war or even now that only those in the business get tubes and parts at a discount? This would discourage the screw-driver mechanic who can't do much better than remove the tubes and have some store or jobber do his testing.

Our trouble could be stopped right at the jobber if only some means for selling only to the serviceman could be devised.

Might I suggest that each serviceman be licensed and given a number of identification so that he can get parts at serviceman's prices and list prices to all others.

I would be pleased to hear from anyone through the medium of this magazine which will enable us to dwell further on this subject, or what other ideas do you in the Radio business have?

P. T. ADAMS,
Cleveland, Ohio

A CONVENIENT TEST BENCH

Dear Editor:

Here is a snapshot of my test panel and work bench, which I trust you may find acceptable enough to publish in your magazine sometime in the near future.

Most of the instruments can be identified easily enough but I'll give a few details about them, as follows: At the left of the panel is a Radio City Model 661 Electronic Multitester. Next to this to the right is a Supreme Model 571 Signal Generator and above this is a Supreme 592 Push Button Multimeter. In the center of the panel is a Hickok 530 Tube Tester.

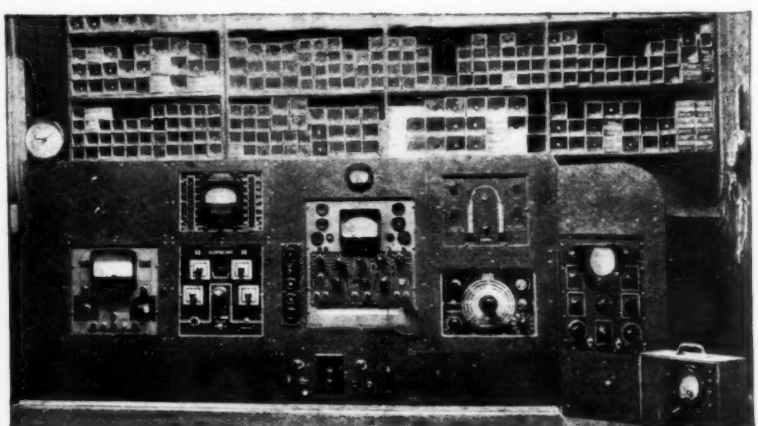
The sockets to the left of the latter are pre-heating sockets for old-style tubes; the bull'seye and toggle and selector switches directly below them being connected to them. The small centre panel with the outlet in it is a variable-voltage transformer, supplying voltages from 105 to 135 volts in steps of 3 volts each. The A.C. voltmeter above the tube tester is connected to this and will show either the line voltage or the output voltage of the transformer. A bull's-eye next to the outlet shows up when either the transformer or the meter is turned on. The transformer is home-wound and I find it very handy as an isolating transformer when aligning A.C.-D.C. radios that have the chassis connected to one side of the power line.

To the right of the tube tester is a Solar CB-1-60 Capacitor Analyzer and above this is a Supreme 529 Electronic Frequency Modulator. To the right of these is the Cathode-Ray Oscilloscope. The instrument at the extreme right is a portable volt-ohm-milliammeter. A small drawer below the scope contains aligning tools, etc.

The panel and bench top are made of Masonite, varnished and waxed. Any instrument can be removed from the panel by just taking off the Masonite from around it and sliding it out.

I've been a regular subscriber to *Radio-Craft* for the past 12 years and have a complete file of the magazine right from 1931 to the present issue. Needless to say, I've found many valuable articles and helps in your magazine in that time. Keep up the good work.

ALVIN L. CAMPBELL,
Innisfail, Alberta, Canada



Nine different test instruments are conveniently grouped around this small test bench.

WANTS A CHANCE FOR YOUTH

Dear Editor:

With all the Radio Defense Courses throughout the country, there should be some place for boys 14 to 17 who have had previous radio experience. Most courses have a 16-year minimum limit.

I have applied for a W.E.R.S. course but was turned down because I was only 14½ years old. There must be thousands of boys around the country like me, who are looking for just this opportunity, but they are overlooked.

Your magazine started me in radio. I have been reading it for four years.

BOB TAYLOR,
Brooklyn, N. Y.

●

FROM A BRITISH READER

Dear Editor:

Just a few words of appreciation for your *Radio-Craft* magazine from an English Wireless Mechanic.

I was lucky to obtain a few 1940 back issues on the way out here, but further efforts to contact your U.S.A. Signalmen for more have proved hopeless!!!

Being keenly interested in QUALITY, A. C. Shaney's articles were particularly interesting to me.

CFN. F. C. CRITCHLEY,
British Expeditionary Forces

●

MORE BUSINESS PROBLEMS

Dear Editor:

I have read your Magazine for the past few years. I enjoy the mail bag section very much and would like to insert my opinion on a few of the points that the other fellows have been talking about.

The past year has been a bad one for us, not because we don't have the business, but because of the shortage of parts and tubes. All good servicemen like to handle the best of quality in all of their merchandise according to their light and I for one can't see why so many of the cut rate places can put out so much more than we can get. I have had only three cases of six B batteries while a local cut rate place has had many more of imitation B batteries. Why critical material and labor is wasted on inadequate products instead of being put in fewer legitimate products at a standard price, I just can't see. But, to quote John Ruskin—"There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people who consider price only are this man's lawful prey."

I draw the line at going out of the shop for work. When you need your car overhauled or repaired you take it to a garage; if your shoes need repairing you take them to a shoe shop. When you need medical care you don't ask the doctor to move his hospital to your house. Why not treat your radios as well? When I started out in servicing three years ago I bought the best instruments I could. Rather than buy cheaper I did without until I could afford the best. They *remain in the shop and are accurate.* Such equipment is too delicate to haul around and let Tom, Dick and Harry cut their teeth on. And have any of you fellows tried to solve a really tough freak set in a home with a half dozen kids playing wild west around you? You know the results.

R. D. gave us a good dose of medicine, although it was very bitter to take. I believe that all service men should be licensed and only licensed shops permitted to buy supplies. Too many wholesalers sell to any one who has a sales tax permit, and many mail catalogues to anybody and sell junk that is a disgrace to the entire industry. Some gyps in the service end are no better.

In closing I wish to state that this is only one man's opinion and is based on experience and is passed along for any good that may be contained. To *Radio-Craft*, let me express my deepest thanks for your splendid magazine and service to the industry. Keep 'em coming.

Yours sincerely,
F. W. FEE,
Pleasantville, Iowa

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Outline of Contents: A Low-Cost Signal Chaser—Signal Tracer Test Unit—Simplified Practical Signal Tracer—A Home-Made Inmite Resistance Tube Checker—Build This Direct-Reading V.-T. Voltmeter—How to Make a Modern V.-T. Voltmeter—Measuring High Values of A.C. Voltage and Current With a Low-Range Meter—How to Make a Meter-Range Extender—How to Build a Practical Tube Tester and Set-Analyzer Adapter—The Beginners' Simple Volt-Milliammeter—Build This Simplified Neon-Type Test Unit—Midget Oscilloscope—How to Make and Use a Frequency Wobbler—Double Tracing Your Oscilloscope—Home-Made Frequency Modulator.

No. 26—Modern Battery Radio Sets

Outline of Contents: Beginner's 1-Tube High-Gain All-Wave Receiver—Beginners-Build This 1-Tube Loop Receiver—A "3-in-1" Battery Portable—An Easily-Built "Flewilling Superregenerative" 2-in-1 "Card File" Battery Set—A 2-Tube Superhet. With Pentagrid Regenerative 2nd-Detector—The 4-Tube Superhet. Vacation Portable—The "Lunchbox 5" Battery Portable—"The Seafarer" Loop-Type Boat Radio Set—4-Tube Permeability Portable—An All-Purpose Portable—A Typical Commercial 3-Way Portable (Pilot Models X-1452 and X-1453)—Switch for Varying "C" Bias on Battery Radio Sets—Making a Simple Portable Aerial—Making a Pilot-Light Fuse—Old Auto Sets for New Cars—Using a Loop Portable in Cars—Quasi-Electric Soldering Iron—Lamp Bulbs as Resistors.

No. 27—Modern Radio Servicing Technique

Outline of Contents: Elementary Servicing Technique—Correct Procedure for the Servicing Beginner—Elementary Procedure for Servicing Radio Sets—A.F.C. Alignment Made Easy—Dynamic Servicing—Dynamic Testing Simplifies Servicing—Modern Receiver Test Requirements—Servicing Universal A.C.-D.C. Receivers—Servicing "Orphans" and Private-Brand Sets—Emergency Servicing Without Test Meters—Servicing Coils—Servicing R.F. Coils—Servicing Oscillator Coils—General Information—RMA Transformer Color Code—What Causes Echo, Fading?—Radio Service Puzzlers.

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(Continued from page 314)

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15.31	GSP	**LONDON, ENGLAND;** 10 am to noon.
15.320	JFY	**TAIHOKU, JAPAN.**
15.330	WGEO	**SCHENECTADY, NEW YORK;** European beam, 7 to 9:45; 10 am to 3 pm; 3:15 to 5:15 pm.
15.345	FGA	**DAKAR, SENEGAL (AFRICA);** 2:45 to 7 pm.
15.350	WRUL	**BOSTON, MASS.;** European beam, 10 am to 2:15 pm.
15.355	KWU	**SAN FRANCISCO, CALIF.;** Australian beam, 4:30 to 6:15 pm daily; Sundays, 4:45 to 6:15 pm; off Wednesday; N.E.I. beam, 7:45 to 9:30 pm; off Wednesdays; South American beam, 11 am to 2 pm.
15.370	ZYC8	**RIO DE JANEIRO, BRAZIL;** 10 am to noon; evenings.
15.410	RV96	**MOSCOW, U.S.S.R.**
15.420	GWD	**LONDON, ENGLAND;** 11 am to noon.
15.45	GRD	**LONDON, ENGLAND;** Near East, Africa and Gilbraltar beam, about noon.
15.465	2RO24	**ROME, ITALY;** off since September 8th, 1943.
15.810	LSL3	**BUENOS AIRES, ARGENTINA;** heard at 6:45 pm.
16.025	AFHQ	**ALLIED HEADQUARTERS, NORTH AFRICA;** daily, 9:18 to 11:30 am (call GBC and GBI).
17.72	LRA5	**BUENOS AIRES, ARGENTINA;** "Radio Del Estado"; Fridays, 5 to 5:30 pm.
17.750	WRUW	**BOSTON, MASS.;** European beam, 10:15 am to 2:30 pm.
17.72	LRA5	**BUENOS AIRES, ARGENTINA;** Fridays only, 5 to 5:30 pm.
17.760	KROJ	**LOS ANGELES, CALIF.;** Australian beam, 9 to 10 pm.
17.760	WKRD	**NEW YORK CITY;** South African beam, 10:00 to 11:15 am; Central Africa beam, 11:30 am to 12:30 pm.
17.780	WRCA	**NEW YORK CITY;** European beam, 9 am to 2:45 pm.
17.780	WNBI	**NEW YORK CITY;** East South American beam 5:30 to 6:45 pm; Sundays, 5:30 to 7:30 pm.
17.800	TGWA	**GUATEMALA CITY, GUATEMALA.**
17.830	WCDA	**NEW YORK CITY;** European beam, 7:45 am to 3:15 pm.
17.870	GRP	**LONDON, ENGLAND**
17.950	——	**UNIDENTIFIED;** signs off about 3:18 pm with "La Marseillaise."
18.135	YDA	**BATAVIA, JAVA (Netherlands Indies);** India beam, 7 to noon.
20.040	OPL	**LEOPOLDVILLE, Belgian Congo.**

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Phototubes have been put to still another use—that of counting the number of revolutions made by an electric motor after the power has been cut. It became necessary to know this in connection with some research work carried out by the G.E. laboratory at Bridgeport, Conn.

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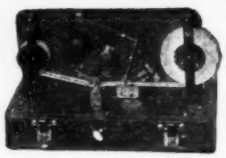

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(While every precaution is taken to insure accuracy, we cannot guarantee against the possibility of an occasional change or omission in the preparation of this index.)

BOOK REVIEWS

A PRIMER OF ELECTRONICS, by Don P. Caverly. Published by McGraw-Hill Book Co., Inc. Stiff cloth covers, 5½ x 8 inches, 235 pages. Price $2.00.

Thousands of men and women engaged in the electrical-electronic industry know little about the products with which they deal. To give them some acquaintance with the science of electronics, and with the principles of operation of the devices they handle, this book has been written. It is the aim of the author to digest the basic principles involved in the behavior of electrons in such a way that they may be understood by the average individual. Further, he intends to present his subject so that the reader may "peruse the book with an interest such as he might show in his newspaper or a novel."

The outstanding feature of the work, as compared with earlier books for the beginner, is the complete by-passing of communications radio as a part of the science of electronics. Mentioned in a few asides, radio is left to other texts, and the emphasis is put on non-radio electronic principles, devices and applications.

The first five chapters of the book are divided into two parts, dealing with electric current and with magnetism (including inductance, resonance and harmonics) respectively. The treatment actually is remarkably simple and explanations are helped by many analogies.

Part Three commences the study of electromagnetic radiation. Six chapters are devoted to this subject. Five of them discuss simple waves and wave propagation principles, light in general, infra-red, ultra-violet, and the waves shorter than ultra-violet. "Slow" oscillations, including radio waves and supersonics, are discussed in the sixth chapter.

Part Four introduces the study of basic electronics and vacuum tube action. In its three chapters a far wider range of electronic tubes is covered than is usually the case in a beginners' book, and the reader leaves it familiar with gaseous-discharge light sources, cold-cathode lights, bactericidal lamps, strobotrons, phototubes, cathode-ray tubes, Iconoscopes, facsimile recorders, the X-ray tube and the electron microscope.

●

NBC HANDBOOK OF PRONUNCIATION, compiled by James F. Bender, with a Foreword by James Rowland Angell. Published by the Thomas Y. Crowell Co. Stiff cloth covers, 6½ x 9 inches, 289 pages. Price $2.75.

In radio communication, by voice as well as by other means, a standard set of signals is a necessity. True it is that the vagaries of pronunciation displayed by our news commentators and announcers are more likely to cause aesthetic pain than confusion to the listener. Whatever the combination of compelling factors may have been, NBC has brought out a book for the guidance of its announcers, with the aim of introducing a standardized and uniform pronunciation of English and foreign words.

The difficulties in the way of compiling such a text are great. Many foreign placenames are pronounced strictly in the English manner. No one would think of referring to the city of Florence by any other name, though it is called Firenze by its inhabitants. Names entirely unknown to the English-speaking world are usually pronounced as the native user pronounces them. A great number of words remain in a shadowy borderland between these two classes. Sebastopol, with its four pronunciations, is an example.

The compiler has, with considerable care and effort, selected 12,000 words and given each the pronunciation to which he believes it is entitled by the weight of good usage. No alternative forms are given, but in some cases the same word appears under two heads. Both Florence and Firenze can be found.

Not only place names, but other often-mispronounced words are included, and indeed make up the bulk of the book. Some of the languages appear to have been favored at the expense of others. The name Saracoglu, which probably holds the record for mutilization by announcers, does not appear, nor does that of his distinguished compatriot, Ismet Inönü. Some liberties are taken with Chinese place names.

Slight inconsistencies are to be expected in a work of such difficulty, and do not detract from its value. The Handbook is likely to be of value not only during the war, but permanently useful to persons interested in accurate speech.

●

ACOUSTIC DESIGN CHARTS, by Frank Massa. Published by the Blakiston Co. Stiff leatherette covers, 6½ x 9½ inches, 228 pages. Price $4.00.

A very complete collection of acoustical engineering data in the highly "available" graph form, this book will serve as a useful reference for anyone working with speakers or other acoustical apparatus, as well as for architects interested in sound.

The author points out that a valuable feature of the graph presentation is that a designer may see at a glance the effect of varying the parameters of a system, thereby saving hours of computations.

There are 107 charts, the majority 4½ by 4½ inches square. Each one is accompanied by a short note and a problem worked out to demonstrate the method of using the chart. Subjects are divided into six sections, beginning with the fundamental relations in plane and spherical sound waves, attenuation, mechanical vibrating systems, and acoustical elements and vibrating systems, going on to the radiation of sound from pistons, directional radiation characteristics, reverberation and sound reproduction, and exponential horns, and concluding with two sections on electro-magnetic design data and miscellaneous data.

Some of the electro-magnetic charts present relations not often seen by the radioman, which are nevertheless extremely useful in loudspeaker design. Such are the graphs showing the length and weight per ohm of copper and aluminum wire vs. wire size, as well as the length per gram vs. wire size, (also for both copper and aluminum). The decibel conversion charts and those showing the loss in decibels due to impedance or phase mismatch between generator and load are more familiar.

PATENT LAW, for Chemists, Engineers and Students, by Chester H. Biesterfeld. Published by John Wiley & Sons, Inc. Stiff leatherette-finished covers. 6 x 8½ inches, 225 pages. Price $2.75.

A digest of patent law is useful not only to the engineer who is in daily contact with patents and patent litigation, but to the experimenter who may not be entirely sure as to whether the device he has conceived may be called an invention, or whether it is patentable or not.

The question of just what does constitute invention is demonstrated in this book by giving excerpts from cases in which the claim of invention was permitted or denied. Other factors than that of invention enter into patentability, and chapters are devoted to Originality, Novelty and Priority of inventions.

A number of points which are only vaguely—if at all—understood by the layman, are cleared up here. Protection by trade secret as opposed to that by patent, and the consequences of selecting one or the other method, are explained, as are disclaimers, abandonment, reissues, double patenting, etc.

Considerable space is given to the permissible breadth of claims, especially in the difficult field of chemical inventions. Numbers of cases in which decisions were made both for and against the inventor, are cited.

Other chapters cover interferences, infringement, liability for infringement, ownership and shoprights and other pertinent features of patent law. The treatment of all subjects is entirely by cases, actual decisions being quoted to illustrate each point.

Manufacturers and business men whose work brings them into contact with inventions and patents will find this little book a useful reference.

●

SUCCESSFUL SOLDERING, by Louie S. Taylor, with an introduction by Emanuel E. Ericson. Published by McGraw-Hill Book Company. Stiff cloth covers, 5 x 7½ inches, 76 pages. Price $1.00.

A short treatise on the the art of soldering, directed to students of industrial art work in the public schools and other individuals interested in craftwork, this little book may be of value to the numerous persons in military and civilian life who have recently become acquainted with the soldering iron.

The various types of fluxes, both for hard and soft soldering, are completely described, together with methods for making them up. The soldering bit is pictured and described in its several forms, and the new craftsman instructed in its use. The various types of solders are then discussed. An interesting chart of the melting point for tin-lead solder of all proportions appears in this section. A discussion of the different sources of heat for soldering closes this portion of the book, which occupies the first 45 pages.

The student is then instructed in the technique of soldering such metals as black iron, zinc and galvanized iron, tin plate, stainless steel, copper and copper alloys, aluminum, tin and pewter, and lead.

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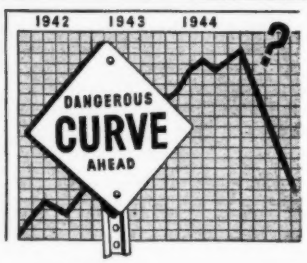

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THE SLIDE RULE

(Continued from page 273)

read the cube on A. For example, find the cube of 2.7.

Set the left index of C to 2.7 on D, then over 2.7 on B will be found the cube, 19.7, on A. Here is the rule for determining the decimal:

RULE FIVE:

For numbers set on C to the left of 215 the characteristic of the cube is 2 less than 3 times that of the number. For numbers on C 215 to 465 it is 1 less than 3 times that of the number, and; To the right of 465 on C it is 3 times that of the number.

To find the cube root of a number place the hair line on the number on A then move the slide until the number on D under the C index is the same as the one on B under the hair line. To illustrate: find the cube root of 64.

Set the hair line to 64 on A, then move the slide to the right until the C index is over 4 on D and the 4 on B is under the hair line, 4 is the cube root.

The cube root of 125 is found by setting the hair line on 125 on A, using the middle 1 as 100, then move the slide until the 5 on D in under the right index of C and also under the hair line on B. The rule for placing the decimal in the cube root is:

RULE SIX:

Mark off the number in groups of three figures from the decimal point. The characteristic of the root equals the number of groups in the original number.

For problems involving Pi, it will be found marked very accurately on all four scales, as well as the reference point .7854.

Proportion may be done easily on the slide rule a:b::c:d. Set the a on C over the b on D, then under c on C will be found d on D.

Example: 2.5:3.5::5:x.

Set 2.5 on C to 3.5 on D, then under 5 on C will be found the answer, 7, on D.

●

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QUARTZ is used for many things other than radio oscillator plates. One of these is the production of supersonic vibrations used in submarine detection and underwater signaling. The quartz crystal, oscillating at a frequency somewhat higher than can be heard as sound by the human ear, is fastened to the hull of an anti-submarine patrol ship. Their vibrations travel through the water like sound waves.

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This system is an old one, having been used in the past in marine sounding machines, though there the question of direction was unimportant, the machines being built solely to determine the distance from bottom. The waves were therefore sent straight down.

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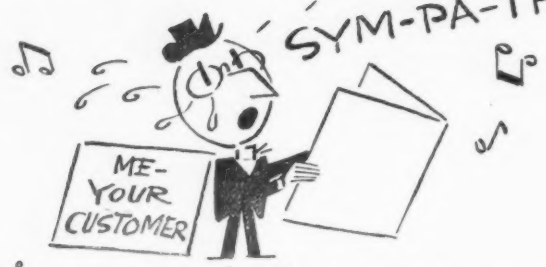

all i want is sym-pa-thy

by don herold

I'm a typical, everyday, bothersome customer of your radio shop.

We have 3 radios at our house, and sometimes one of them goes haywire—although they usually work wonderfully—considering the beating we give 'em.

I know there's a war on, and I know you radio fellers have a heck of a time getting parts and help. I know you're on a spot. So I don't expect you to fix my radio as fast or as good as you usta.

But—this war is on my nerves, too. I'm thinner-skinned than usual! I'm sensitive! I'm tender!

So please be a little kind to me, mister. Please explain a little why you can't do this or that—and I'll stand for most anything!

I quit one radio man because he barked at me and kept putting off my repair job and didn't tell me why.

I've gone over to another radio feller who isn't any faster than the first one, but who takes the trouble to always rub my fur the right way.

This is the shop that's going to get my repair business after the war, and I'm hoping to buy a new FM set and a television outfit and a lot of electronic gadgets some day—and this shop'll be tops with me for all that business . . . and maintenance on it.

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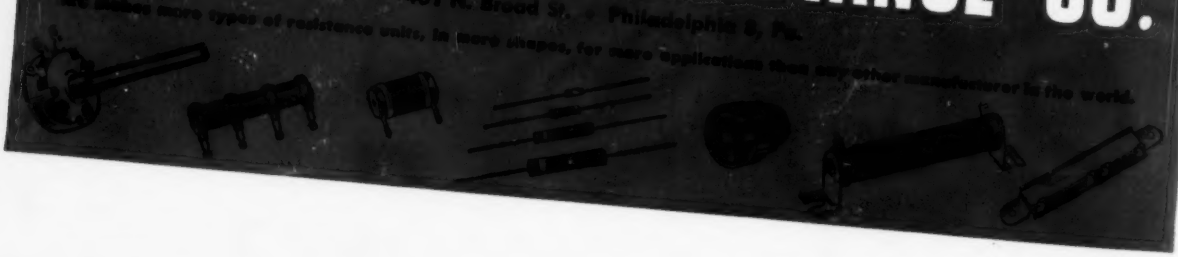
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